BRITISH JOURNAL OF TUBERCULOSIS
AND DISEASES OF THE CHEST
Vol. LI. October, 1957 No. 4.

PNEUMOCONIOSIS IN FOUNDRY WORKERS*

By A. I. G. McLaughlin

From the Factory Department, Ministry of Labour and National Service.

The casting or founding of iron and other metals is an ancient occupation, dating from the Bronze and the Iron Ages. The articles which can be made by the casting method vary from a fraction of an ounce, like boot sprigs, to parts of large machines weighing hundreds of tons. Since ancient times the occupation has been known, but not clearly, to be harmful to health of foundrymen, mainly because it is dusty. The history of foundry health risks is, therefore, largely that of the pneumoconioses. The work is hot as well as dusty, and the workers are subjected to sudden changes of temperature. It also calls for the expenditure of much physical energy, though in modern foundry practice a good deal of the excessive physical effort has been diminished by mechanical aids such as cranes and other lifting tackle. It is said that foundrymen show a high incidence of bronchitis and pneumonia and that they also suffer unduly from rheumatism and hernia.

The earliest reference to metal founders appears in a book by Paracelsus (1493-1541). He was a Swiss doctor and alchemist, highly unpopular with his contemporaries, and also known as Bombast. Between 1510 and 1520 he had worked as a miner and a metal founder at Schwaz in the Tyrol. His book was published in 1567 after his early death to which his work in the mines and foundries is said to have contributed. Oddly enough, he did not ascribe the pulmonary diseases of miners and founders to the inhalation of dust, but to the influence of the astral bodies, though he did recognise that mineral emanations and the "climate" of the mines might partly cause the lung trouble. It was Georgius Agricola (1494-1555), however, who first mentioned dust as the probable cause. In his book "De Re Metallica," published in 1557, he maintained that the inhalation of "corrosive" dust predisposed a worker to a disease characterised by exhaustion, coughing and "that difficulty of breathing which the Greeks call asthma," but he confused the condition with tuberculosis. He pointed out that in the Carpathian mountains there were women who had married seven husbands, "all of whom this dreadful disease had brought to an early grave." He did not seem to be aware of the significance of the fact that female contacts did not contract the disease, nor that it was the first hint that tuberculosis and pneumoconiosis are not the same, though they may be, and often are, associated. The confusion between pneumoconiosis and tuberculosis was gradually resolved by later investigations, and particularly after the discovery of the tubercle bacillus, but even today there is some confusion,

* Based on a lecture given at the Institute of Diseases of the Chest, Brompton Hospital, on December 5, 1956.

(*Received for publication May* 14, 1957.)

because of the naked-eye and histological similarity of the nodule of silicosis and the tubercle of tuberculosis. As recently as the 1930s some French physicians were denying that there was such a disease as silicosis, and today there is controversy about the ætiology of massive pneumoconiosis, which many investigators maintain is always tuberculous.

In the early part of the nineteenth century Laennec attacked with vigour the idea that the " concrétions osseuses cretacées du poumon " found in workmen in certain dusty trades were caused by dust inhalation, and he maintained that dust was always expelled in a short time from the lungs and therefore could not harm them. Calvert Holland, of Sheffield, in his little-known book " Diseases of the Lungs from Mechanical Causes," published in 1843, takes the opposite view with equal vigour. He knew Laennec well and had worked with him in Paris, but he writes: " The strangeness of his opinions can arise only from not having enjoyed ample opportunities of investigating the matter, on which he presumed to express a decided opinion." He goes on to say that " it is seldom that the metropolis of any country offers frequent occasions for investigating the influence of important branches of manufacture on the human constitution. To observe these in their variety and activity, and to appreciate justly the tendency with which they are fraught, the inquirer must be long resident in the provinces, where only they can be studied with advantage, and in connection with many modifying circumstances. The position of Laennec did not present these peculiar facilities. . . ."

Holland, by his clinical and post-mortem studies, established clearly the difference between silicosis and tuberculosis, and like Peacock and Greenhow, some twenty years later, did so without the aid of X-rays and bacteriology. Holland deals only with the pulmonary diseases of grinders of scissors, forks, needles, razors, pen-knives, table-knives, saws, files and scythes. It is remarkable that he does not mention foundry workers, and it seems likely that the conditions in the Sheffield grinding trades were so bad that similar risks to the health of foundry workers were overlooked or overshadowed. Indeed it was not until Middleton (Macklin and Middleton, 1923), in carrying out his investigation into the health of grinders, included some casting cleaners in the series, that foundry work was brought under suspicion in this country. Of 201 fettlers of steel castings, he found that 22·8 per cent. of them had pulmonary fibrosis and 6 per cent. had tuberculosis. By comparison, a group of 495 sandstone grinders showed 73 per cent. of pulmonary fibrosis and 21 per cent. had tuberculosis; the cleaning or fettling of castings was therefore thought to be a less unhealthy job than grinding. It ought to be noted, however, that at that time the cleaning of castings was done mainly with hand tools and not with pneumatic hammers which came into more general use later. Nowadays steel fettling is a much more dangerous job than grinding because the pneumatic hammer creates much more dust than the hand hammer, and also because the sandstone grinding wheels have been replaced by non-siliceous ones such as carborundum, emery and alumina. Again, since 1929 grinding by regulation (with certain exceptions) has to be done under exhaust ventilation, whereas the fettling of steel castings until recently has been done without any form of dust control. From January 1, 1956, exhaust ventilation has to be applied to it " so far as reasonably practicable."

Since 1930 more attention has been given to the pneumoconioses of foundry workers. Groups of them have been examined in all the industrial countries of the world, notably in the U.S.A., Germany, Belgium, France, Italy, Switzerland, Norway, Denmark, Sweden, Japan and Australia. In this country Keatinge and Potter (1945), Keatinge and Harding (1954), have described surveys of the workers in an iron foundry; and in 1950 my colleagues and I (McLaughlin and others) published an account of a survey of just over 3,000 workers in nineteen iron and steel foundries. In this article I propose to discuss the conclusions drawn from this and later investigations.

At the outset it should be emphasised that the risk of pneumoconiosis varies from one foundry to another, and also from job to job in the same foundry, simply because some foundries and some jobs are more dusty than others. The whole problem is a great deal more complicated than that of pneumoconiosis in coal miners.

Foundry Processes

In the making of a casting there are certain processes common to all foundries, whether the casting be in iron, steel, or in one of the non-ferrous metals. The various stages are shown in Table I.

Table I.—Foundry Processes

1. Pattern making—die-making.
2. Sand preparation—for mould and core sands.
3. Moulding—making of moulds and cores. Use of parting powders and mould paints.
4. Furnaces—melting of metal.
5. Pouring or teeming of molten metal.
6. Cleaning processes:
   - (i) Knocking-out and stripping.
   - (ii) Shotblasting, wheelabrators.
   - (iii) Hydroblast—water blast.
   - (iv) Grinding—Portable grinder.
     Stand grinder.
     Swing frame grinder.
   - (v) Fettling (dressing) with pneumatic tools.
     „ „ „ rumblers.
     „ „ „ brushes.
7. Electric welding and oxyacetylene cutting.

A pattern of the metal casting is first made in wood. The pattern shop is essentially a wood-working shop; it is separate from other foundry shops, and is the least dusty of them. The workers are exposed mainly to wood dust, most of which comes from the sanding machines, and there is a little free silica (SiO_2) which comes from the sandpaper on the wheels.

Metal moulds or dies are also used mainly in non-ferrous foundries and the process is known as die-casting. Iron pipes are sometimes cast in spinning metal as well as sand moulds and this process is known as centrifugal casting.

The pattern is put into a moulding box (which is in two halves), rammed round with moulding sand, after which it is taken out, leaving its impression in the sand. When molten metal is poured into this impression, and when the metal cools, a solid casting is made. If a hollow casting is needed, a sand core is put into the impression left by the mould in the pattern, and the molten metal then fills the space left between the core and the outer mould.

After the metal has cooled and hardened, the moulding and core sands are taken away from the casting by processes known as "knocking-out" and "stripping." The final cleaning of the casting is known as "dressing" or "fettling."

The dusty jobs are sand preparation, the application of parting powder to the moulds by shaking it from a muslin bag, the knock-out and all the fettling or cleaning processes. Mould and core sand is usually damp and little dust is evolved during the making of moulds and cores. Iron oxide fume is given off during the melting of the metal in various types of furnace, during the teeming or pouring of the molten metal and from the processes of welding and oxy-acetylene cutting. Mould and core mixtures have in addition to sand (with a high SiO_2 content) binders such as clays, organic constituents such as dextrin, molasses and linseed oil, and recently resins of various types have been used.

Foundry workers are exposed to dust containing free silica, carbon (from coal or pitch added to the moulding sand), clay and iron oxide, and the products of pyrolysis of the organic binders. This brief description of foundry processes of necessity does not include all the technicalities or methods of foundry practice, but it will be enough to show in general what substances may be in the foundry atmosphere. Detailed descriptions will not be given of two new methods of making moulds, one known as the "CO_2 process" and the other as "shell moulding."

It might be added that the dust from the cleaning or fettling processes is of smaller particle size and usually in higher concentrations than the dust in the moulding and knock-out processes. In iron foundries the parting powders referred to above consisted at one time of fine silica flour, but this was banned in 1949 by the Parting Powder (Special) Regulations.

Pathology of Foundry Workers' Lungs

Though there have been about twenty-eight surveys of groups of foundry workers in various parts of the world since 1930, only one of them included pathological studies. This was the one which my colleagues and I published in 1950. By contrast, in other dusty industries, such as coal, gold and hæmatite mining, in the potteries and boiler scaling, there is a wealth of pathological material from which sound conclusions can be drawn about the health risks of these industries. Most of the conclusions about foundry workers have been made from X-ray studies.

Until recent years the classical whorled silicotic nodule (Fig. 1) has dominated the study of the pathology of the pneumoconioses. For instance, the fibrosis in the lungs of iron fettlers was thought not to be caused by the occupation, because no typical whorled nodules were found. Classical silicosis occurs in the lungs of workers exposed to the inhalation of dust containing a high proportion of free silica, notably gold miners, sandblasters, steel dressers and the makers of siliceous scouring powders. But it has been found that workers who inhale mixed dusts containing a small proportion (under 10 per cent.) of free silica will also develop nodular fibrosis, but not of the classical type. The arrangement of the reticular and collagenous fibres is linear and radial and the outline of the whole nodule is irregular and stellate. A typical nodule,

to which Harding, Gloyne and I have applied the term " mixed dust fibrosis," is seen in Fig. 2. This was found in an iron fettler and may be regarded as modified silicosis. Similar nodules have been found in other groups of foundry workers, in workers exposed to the dust of graphite containing about 10 per cent. of free silica and in boiler scalers who are also exposed to a mixed dust containing varying but always low percentages of SiO_2. The coal nodule has much the same appearance as the mixed dust nodule, and coal dust does contain small amounts of free silica. The common denominators of all these dusts are carbon and free silica, but carbon does not appear to be a necessary component, because a fibrosis with a similar arrangement of fibres is found in many hæmatite miners, who are exposed to a mixed dust containing hæmatite and free silica and no carbon. In coal miners the condition has been called " simple pneumoconioses," but I regard the term " mixed dust fibrosis " as more in keeping with the ætiology.

In the same case there may be both the classical silicotic and the mixed dust fibrosis nodules, together with others showing a transitional stage between the two types (Fig. 3).

In the foundry workers all three types of nodule are found, and the histological appearances can be roughly correlated with the composition of the dust in the different jobs. They illustrate the fact that the composition and the concentration of the dust change from time to time, even from hour to hour. It was Belt, I think, who called the lungs a palimpsest of the dust exposures—a kind of historical document with the pages pasted over each other.

In sand and shotblasting there is a high proportion of SiO_2 in the dust and therefore the classical nodule is mainly seen in these cases. In general the dust in steel foundries contains a higher proportion of SiO_2 than in iron or non-ferrous foundries. The classical nodule is found more often in steel foundry workers than in those of iron foundries, in which the mixed dust nodule is the characteristic lesion. Again, the moulding shop dust in all types of foundries is lower in SiO_2 than in the cleaning or fettling shops, and mixed dust fibrosis is found more than classical silicosis in the moulding shops. But there is an exception to this general rule. Iron moulders who used silica parting powders in large quantities (now banned by regulations) contracted well-marked classical silicosis. The cleaners of iron castings usually show the stellate nodules of mixed dust fibrosis, but those who clean steel castings get more classical nodules than the mixed dust ones.

These nodules, both the classical and the mixed dust ones, coalesce to form large masses in the lungs, usually in the upper and outer parts of the upper lobes. It is maintained by many investigators that massive pneumoconiosis is always tuberculous in origin, particularly in coal miners. It is true that many of these cases do have tuberculosis, but on the other hand many do not. There is also evidence that infection with the tubercle bacillus stimulates the formation of the fibrous nodules in the lung lymphatics round dust deposits; and that there are cases in which the individual nodules contain elements of silicosis and/or mixed dust fibrosis and of tuberculosis. Fig. 6 shows the X-ray film of a steel fettler with massive shadows, who could on the X-ray appearances be diagnosed as tuberculosis superimposed on silicosis. And, in fact, he was so diagnosed during life. At autopsy, however, there was no sign of tuberculosis, and Fig. 7

shows the massive silicosis found on histological examination. The nodules are jammed together under a thickened pleura. By contrast, Fig. 8 shows nodules containing elements both of silicosis and tuberculosis, each nodule having a caseous centre. This man had been an iron moulder for eighteen years and he had used large quantities of silica parting-powder. He was only 32 years of age at death. Two of his mates, also in the thirties, died from silicosis about the same time, but in these two cases tuberculosis was not found at autopsy.

Causes of Death in Foundry Workers

Though large numbers of foundry workers contract pneumoconiosis (silicosis and/or mixed dust fibrosis) and it is a prominent cause of death amongst them, they quite often die from other causes. Table II shows the main pathological lesions found in 155 foundry workers, all of them being males except two (McLaughlin and Harding, 1956).

Table II.—Pathological Lesions in Foundry Workers

Occupational group	*Total No. of workers*	*Pneumoconiosis*	*T.B.*	*Carcinoma bronchus*	*Pneumonia*	*Bronchiectasis*	*Coronary thrombosis*
Steel fettlers ..	37	36	22	3	7	2	1
Steel grinders	13	12	5	2	3	1	2
Steel moulders	1	1	—	—	1	1	—
Iron fettlers ..	15	15	11	2	5	4	—
Iron grinders	5	5	3	1	1	1	1
Iron moulders	21	21	7	—	6	2	1
Shot and sand-blasters ..	26	26	13	2	5	3	2
Welders and cutters ..	6	4	—	—	—	1	1
Non-ferrous moulders ..	4	4	1	—	—	—	—
Non-ferrous fettlers ..	2	2	—	—	1	1	1
Furnace bricklayers	3	3	—	1	4	—	—
Furnace labourers ..	8	8	1	2	2	2	3
Core makers ..	3	3	1	1	2	—	—
Crane drivers	3	2	1	—	—	—	1
Foundry labourers ..	6	2	1	2	—	2	3
Pattern maker	1	1	—	—	—	—	—
Stone racer ..	1	1	—	—	—	—	1
Totals ..	155	146	66	16	37	20	17

Harding and I have been collecting these cases over the past six years and the group includes workers from most of the foundry occupations in all types of foundries, iron, steel and non-ferrous. The larger numbers come from steel and iron castings cleaning shops, and there were twenty-one iron moulders, but only six non-ferrous foundry workers.

All except nine had pneumoconiosis (silicosis and/or mixed dust fibrosis) in varying degrees of severity, but in only just under half of them was it the

actual cause of death. Other pathological lesions found were tuberculosis (sixty-six cases or 45 per cent.); carcinoma of the bronchus (sixteen cases or about 10 per cent.); pneumonia (thirty-seven cases or about 2·4 per cent.); bronchiectasis (twenty cases or 12 per cent.) and coronary thrombosis (seventeen cases or about 11 per cent.).

Chronic bronchitis and emphysema, associated with cor pulmonale, was commonly found. The emphysema was either bullous, generalised or focal. Focal emphysema was more often seen with mixed dust fibrosis than with classical silicosis. Fig. 4 shows mixed dust fibrosis with focal emphysema, and Fig. 5 silicosis also with emphysema. Clinically, bronchitis and emphysema are commonly seen in association with most of the dust lesions of the lungs. But it is difficult to prove how much of it is " trade-made " or " town-made " from air pollution and other causes.

Tuberculosis as a complication of the pneumoconioses of foundry workers is becoming less common, as it is in other groups of the population, but cancer of the lung is increasing. There is evidence that some of the increase of cancer of the lung in foundry works may be caused by the occupation. Some of the substances encountered in the job, such as mineral oil, tars, pitch used in moulding sand, and the products of pyrolysis of the organic binders, may possibly be responsible for some of the increase. Even iron has been incriminated as a possible carcinogen. Faulds believes that hæmatite dust (Fe_2O_3) may be responsible for the increase of carcinoma of the lung in hæmatite miners, and there is some experimental and statistical evidence to support the theory. But up to the present time, though the evidence is suggestive, the theory has been neither proved nor disproved.

Chemical analysis of the mineral content of the lungs of foundry workers shows that total silica, free silica and iron are found in varying proportions. There is a general increase of both total and free silica, with increasing fibrosis, but the overlap between groups is wide. The figures for total silica vary between 0·03 and 2·7 per cent., whereas those for free silica range between 0·01 and 1·30 per cent. of the dried weight of the lung. Even lungs without fibrosis have some free silica in them, of the order of 0·02-0·32 per cent.

Estimations of iron in the lungs of sixty-three foundry workers gave an average of 1·035 per cent. of the dried lung, with a range from 0·20 to 3·76 per cent. The average is about six times greater than that given for normal lungs of comparable age groups. The iron and silica contents of the lungs have a bearing on the contention by Hamlin and Weber (1950) in the U.S.A. that the abnormal X-ray shadows in foundry cleaning room operatives are caused by deposits of iron in the lungs (siderosis) and not by pneumoconiosis. This contention is based on two points—(i) that their workers were exposed to high concentrations of iron oxide dust and to small concentrations of free silica, and that (ii) animals exposed to foundry dust for three years did not get fibrosis of the lung. Their conclusions were not based on human pathology, and in any case others (*e.g.* Keatinge and Harding, 1954) have found that foundry dust can cause fibrosis in experimental animals.

There is no doubt that all categories of foundry workers can contract pneumoconiosis of varying severity, even though they inhale large quantities if iron, which is thought to be one of the antidotes to free silica. It is clearly

not a very good antidote. The pneumoconiosis risk is greatest in the cleaning or fettling shops of all foundries and least in the pattern shops.

As regards the non-ferrous foundries, no large survey has been carried out in this country, but it is known that pneumoconiosis does occur amongst the workers. Surveys by X-ray have been made in other countries—*e.g.*, U.S.A. and Italy—and abnormal X-ray changes have been found. Harding and I (1955) have published details of six deaths from pneumoconiosis, four of them being moulders and two castings cleaners.

X-ray Appearances

The X-ray appearances of silicosis and mixed dust pneumoconiosis are much the same, and indeed most of the dust diseases, with the exception of asbestosis, have comparable X-ray patterns. This is because dust gets into the peribronchial and periarterial lymph channels and is held up at key points in the primary lobule. The flow of lymph is both towards the bronchial glands and the pleura and it will be observed that the greatest accumulation of dust (with accompanying fibrosis) is near the upper aspects of the visceral pleuræ and in the hilar lymph glands. When massive shadows occur they are usually found near the upper and outer aspects of the lung fields, and not in the subclavicular and apical areas which are the common sites of election of tuberculosis.

Numerous classifications of X-ray appearances have been drawn up for different industries and it is true that, up to a point, each industry has its own X-ray pattern. When anyone is doing a survey of an industry, he usually finds that he has to draw up his own classification of X-ray appearances, ranging from the earliest X-ray signs of dust retention to those of advanced stages of pneumoconiosis. Quite often there is no correlation between X-ray appearances and clinical signs and symptoms of disability.

But in general there are fairly distinct stages of the X-ray appearances of the dusty lung, though naturally they tend to merge one into another.

To illustrate the appearances in foundry workers I shall take the stages occurring in one steel foundry situated in a small country town where there are few other factories and there is comparatively little air pollution. The X-ray films were all taken on the same day with comparable technique.

First there is the *normal lung* shown in Fig. 9. This was a boy of 14½ years of age who had worked as a steel moulder for only six months.

Next, there is the stage of *increased linear striation*, illustrated in Fig. 10. This was the film of a man of 37 years of age who had worked as a steel moulder in the same foundry for twenty-three years. He was not disabled. There is an increase in the lung markings and also in the midzones a fine stippling giving a ground-glass appearance. Though increased linear striation is found in asthma and emphysema, and most radiologists are of the opinion that the linear shadows are caused always by blood vessels, I think that in this case the lines are also due to dust in the peribronchial as well as in the perivascular lymph channels. When the lymphatic network in the walls of the bronchi and vessels are filled with dust, some of it radio-opaque, it is difficult to understand why they should not cast shadows on the film. The stage of increased linear

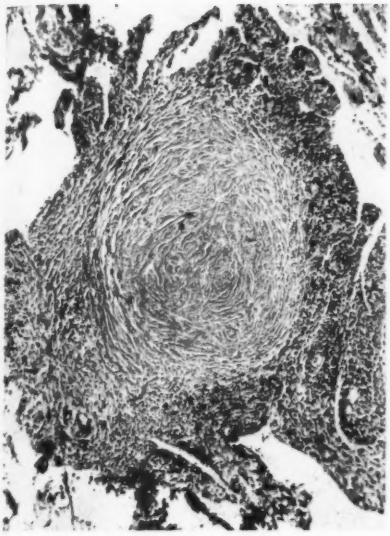


FIG. 1.—Photomicrograph of section of lung of sandblaster; whorled silicotic nodule in area of mixed dust fibrosis. Hæmatoxylin and eosin; ×57·7

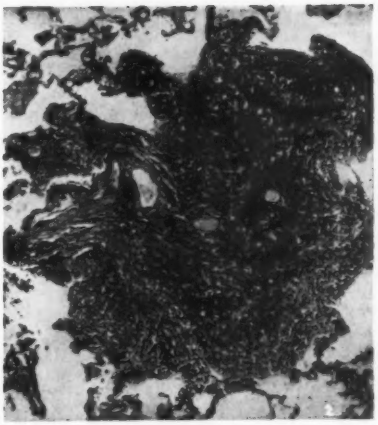


FIG. 2.—Photomicrograph of section of iron fettler's lung; mixed dust fibrotic nodule. Hæmatoxylin and eosin; ×21·6.

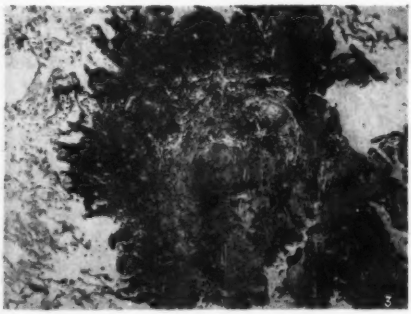


FIG. 3.—Photomicrograph of section of steel fettler's lung; transitional nodule showing both whorled fibrosis of silicosis and radial fibres of mixed dust fibrosis. Hæmatoxylin and eosin; ×21·6.

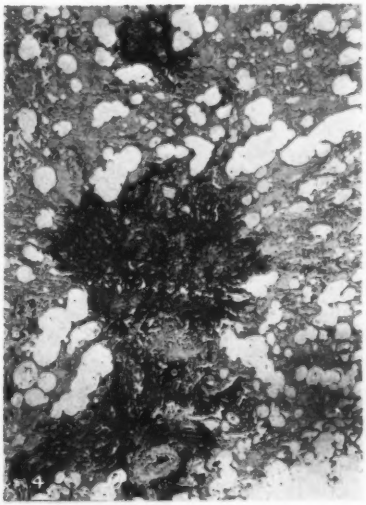


FIG. 4.—Photomicrograph of section of lung of steel fettler; showing mixed dust fibrosis with focal emphysema. Hæmatoxylin and eosin; ×10·8.

To face p. 304

FIG. 5.—Photomicrograph of section of lung of iron moulder; showing silicotic nodules with focal emphysema. Hæmatoxylin and eosin; ×9.

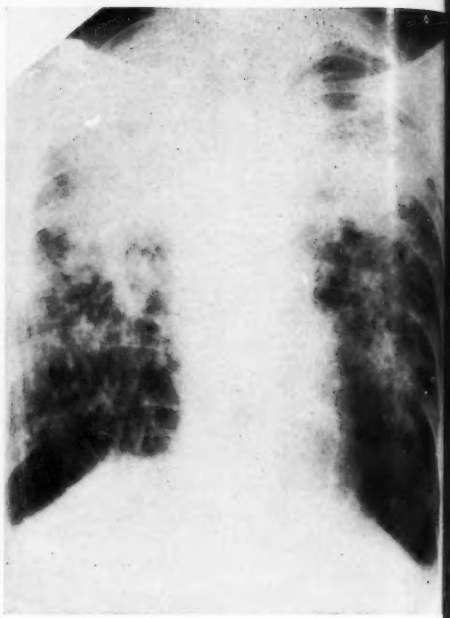


FIG. 6.—Radiograph of chest of steel fettler showi scoliosis, deviation of trachea to right and " peaking of right diaphragm; nodulation over both lung fiel with massive shadows in both upper zones, m marked on the right. No tuberculosis found autopsy.

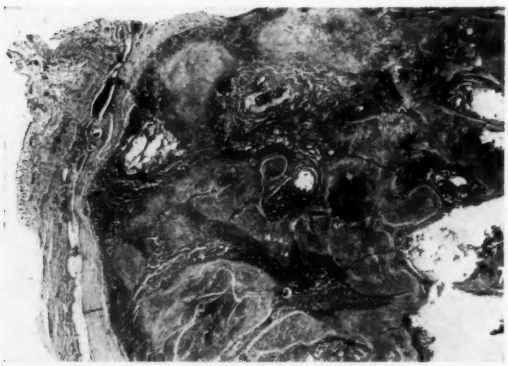


FIG. 7.—Photomicrograph of section of lung of steel fettler; (see Fig. 4) showing massive silicosis and thickened pleura. Hæmatoxylin and eosin; ×4·5.

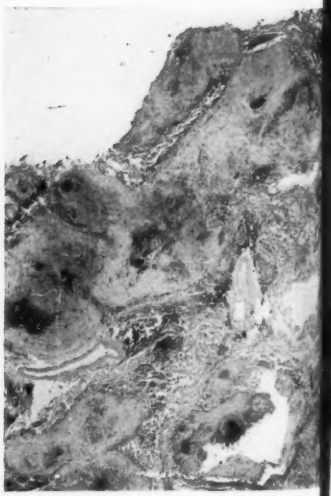
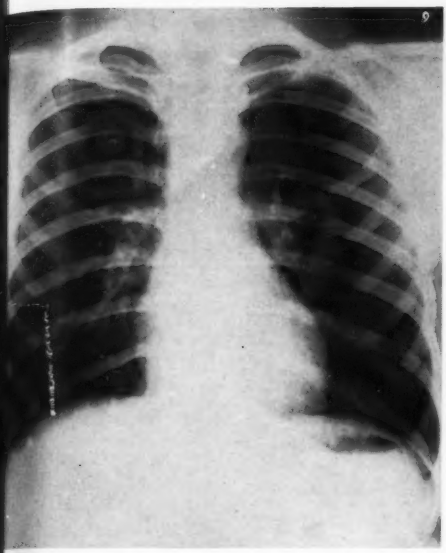


FIG. 8.—Photomicrograph of section of lung of iron moulder; showing massive silico-tuberculosis. Hæmatoxylin and eosin; ×4·5.



9.—Radiograph of chest of steel moulder, aged 14½. Normal chest.

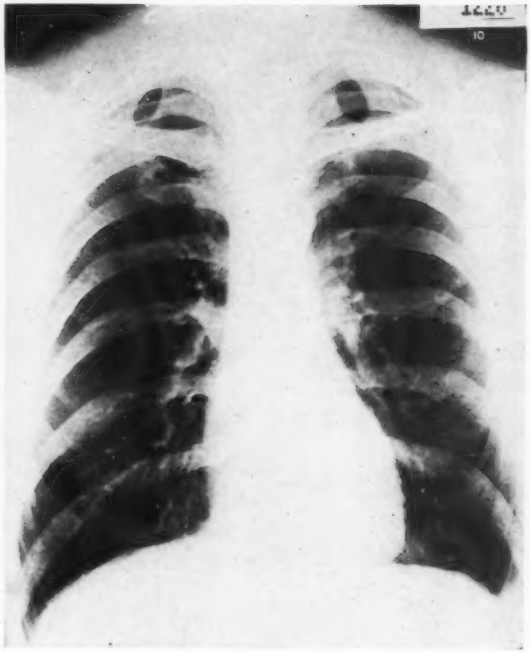
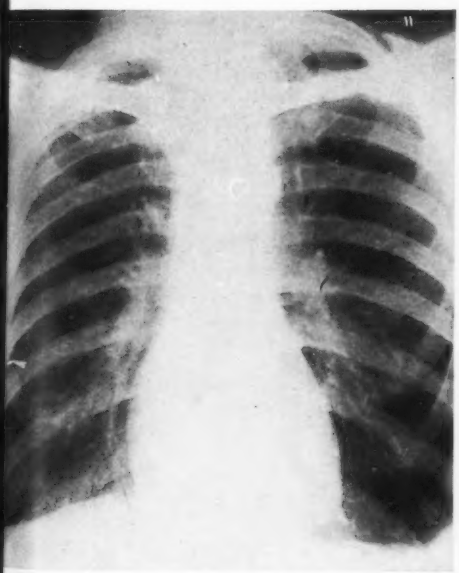


FIG. 10.—Radiograph of chest of steel moulder for 23 years (aged 37) showing increased linear striation.



11.—Radiograph of chest of steel moulder for 58 (aged 71), showing generalised reticulation.

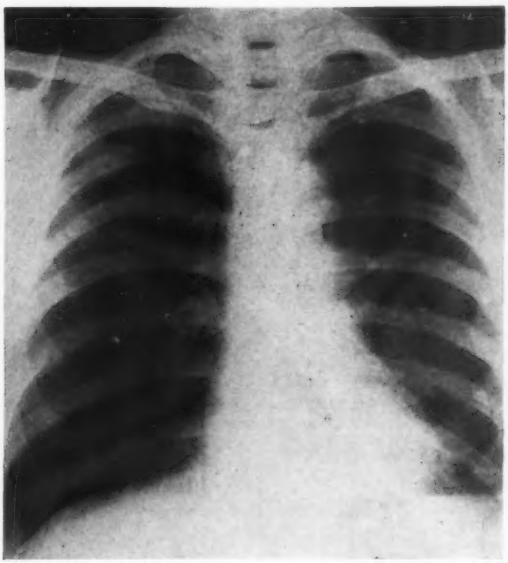


FIG. 12.—Radiograph of lungs of steel fettler for 30 years (aged 61). Generalised nodulation with beginning coalescence in right upper lateral zone.

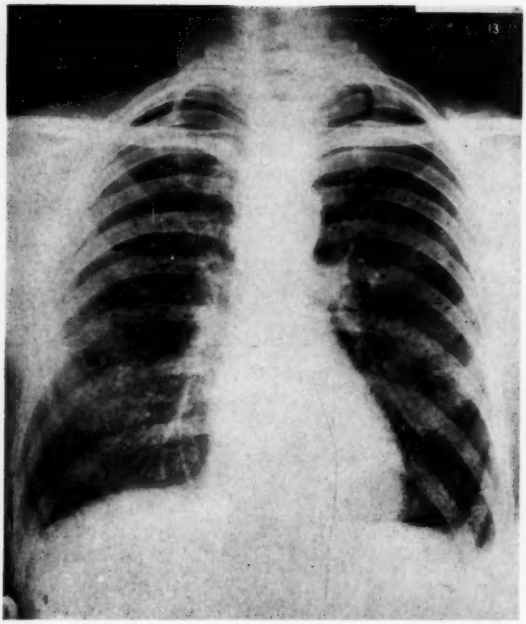


FIG. 13

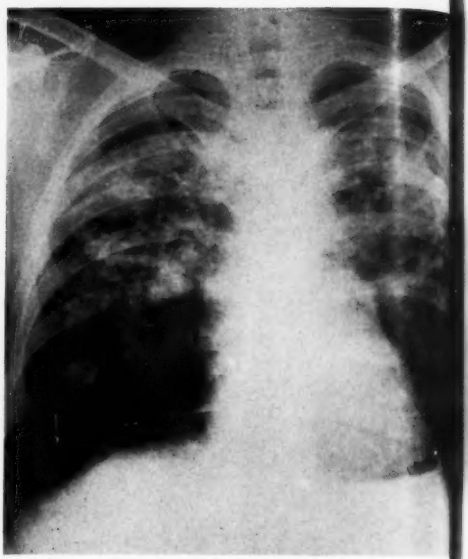


FIG. 14

FIG. 13.—Radiograph of lungs of electric arc welder who had worked in a steel fettling shop for 23 years. Previously a steel fettler 6 years (aged 47). Generalised nodulation typical of welder's siderosis.

FIG. 14.—Radiograph of lungs of steel fettler for 31 years (aged 45). Appearances are those of nodulation with massive shadows in the upper zones.

FIG. 15.—Radiograph of lungs of steel fettler for 13 years (aged 36). Reticulation with massive shadows in upper zones. Clinically the patient had tuberculosis.

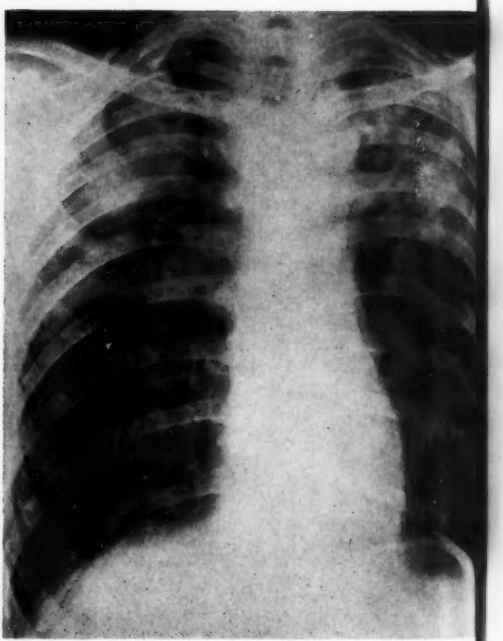


FIG. 15

striation is not taken into account in the classification of X-ray appearances of coal miners drawn up by the Pneumoconiosis Research Unit (Fletcher *et al.*, 1949;), but it is always shown as a stage in American classifications of X-ray appearances of pneumoconiosis (*e.g.* Brown and Klein, 1942).

The next stage is *reticulation*, a term which has been discarded by some authorities, but which is regarded by others as useful. In general, descriptive terms are more useful than code numbers and letters, more particularly when the standard films on which the numbers and letters are based are not universally available. Fig. 11 shows the stage of reticulation. This man was 71 years of age and had been a steel moulder for fifty-eight years. It is a good example of the condition which, though made up of small nodules, gives the appearance of a network. There are a few larger nodules in the upper and outer lateral zones. The chest expansion was only 1½ inches, but he had little or no disability. This was the most advanced X-ray change found in the moulders at this foundry. It was found in the survey that the moulding shop was not very dusty, and the average dust concentration in the atmosphere was only about 800 particles per c.c. By contrast, the castings cleaning or fettling shop was a great deal more dusty, the average dust concentration being 15,000 particles per c.c. Here more advanced X-ray changes were found.

The intermediate stage of *reticulo-nodulation* is not illustrated. But one man 47 years of age had worked as a steel dresser in the fettling shop for twenty-three years—*i.e.*, the same length of time as the moulder whose X-ray film showed only the stage of increased linear striation. In his X-ray film the nodules were larger, particularly in the upper lateral areas, and in some areas there was the appearance of a coarse network. Clinically he was dyspnœic and had pain in the chest on deep breathing. He was diagnosed as a case of early silicosis.

The next stage (Fig. 12) is that of *nodulation* or classical "snow-storm" silicosis. The nodules are larger, and they are beginning to coalesce in the upper lateral zones, which, as mentioned above, is the usual place for coalescence of the shadows to begin. This man had been a steel dresser for thirty years; his chest expansion was only 1½ inches and he had moderate dyspnœa. There was no doubt that he had silicosis.

Fig. 13 shows another X-ray film with X-ray nodulation, but in this case a diagnosis of silicosis is not so certain. He is an electric arc welder of 47 years of age who had worked as a steel fettler for six years and then as a welder for twenty-three years in the same fettling shop. He had been inhaling more iron oxide fume than SiO_2, and the condition is probably one of siderosis (or possibly mixed dust fibrosis) rather than silicosis. He was not disabled; his chest expansion was 3 inches; the exercise tolerance and cardiac response to effort were good; the only abnormal signs on auscultation were that the breath sounds were distant over the lower lobes with some post-tussic crepitations. A diagnosis cannot be made on an X-ray film alone, but if the condition is one of welder's siderosis, there will be no coalescence or massing of the shadows.

In the next case there are *massive shadows* (Fig. 14). This man had been a steel dresser in the same foundry for thirty-one years and had done no other job. The massive shadows are well shown in the upper zones, over a background of nodulation. He was still working when I examined him (as indeed were all cases described here) and he did not know that anything was wrong with his

chest. He was slightly cyanosed; the chest expansion was 2 inches; cardiac response to effort was 80 : 108 : 90 and his tolerance to exercise was slightly impaired. The percussion note was hyper-resonant all over the lung fields, the breath sounds were roughened with crepitations and high-pitched rhonchi over both upper zones posteriorly and post-tussic crepitations at the bases.

To show the difference between coalescent silicosis and tuberculosilicosis, Fig. 15 gives the chest X-ray film of a man whom I examined on the same day as the previous case. He was 36 years of age and had been a steel dresser for thirteen years. Previously he had worked on a farm. Though he was still working, he said that he felt very ill, and that he had lost about a stone in weight during the year. For three to four months he had been short of breath with a cough, copious sputum, night sweats, lassitude and sharp pains over the sternum. The pain became easier when he had a few days off work.

On examination he was thin and slightly cyanosed; chest expansion only ½ inch; cardiac response to effort 120 : 132 : 110, and his tolerance to exercise was impaired. There was restriction of movement of the left side of the chest, and wasting of the shoulder girdle muscles. The percussion note was impaired over both upper lobes, more on the left side, and over the left upper zone there was bronchial breathing with increased vocal resonance and post-tussic crepitations. Two specimens of sputum did not show tubercle bacilli, which, however, were present in a third specimen examined some months later.

The X-ray picture is not markedly different from that of the previous case, though there is some evidence of cavitation in the left upper lobe. The differential diagnosis was made mainly on clinical grounds and not on the X-ray appearances.

Incidence of Pneumoconiosis

In order to give the incidence of the pneumoconioses in any industry, the populations exposed to the inhalation of dust in each job must be accurately known. As far as foundries are concerned, these figures are not known with any degree of certainty, but there are between 200,000 and 300,000 foundry workers in this country, including iron, steel and non-ferrous foundries. Even if one had the accurate populations of workers in each type of job, and it could be said, for instance, that 5 per cent. of them had pneumoconiosis, it would not tell us much, because quite often there are varying degrees of danger and dustiness in different jobs in the same foundry. And the danger varies from foundry to foundry, depending on the efficiency of the dust control methods. The incidence varies with the length and concentration of exposure of each individual, and also with his susceptibility to dust. Of two men who have been working at the same job for the same length of time, one may contract pneumoconiosis and the other may be unaffected by it.

In a series of eight deaths in one steel fettling shop, seven of the men died from silicosis, in some cases associated with tuberculosis. The eighth man, who had worked there for thirty-six years, and had done no other job, showed no pathological or X-ray evidence of silicosis or of mixed dust fibrosis. He died from carcinoma of the lung.

However, by examining large numbers of workers, one can get a fair idea

of the incidence of pneumoconiosis in each occupation. Table III gives the results of X-ray examination of 2,767 iron and steel foundry workers.

TABLE III.—INCIDENCE OF PNEUMOCONIOSIS IN 2,767 FOUNDRY WORKERS

Occupation	*Metal*	*No. of workers*	*Percentages of X ray categories*		
			I	*II*	*III IV*
Moulding shop	Iron	609	75	18	7
	Steel	501	65	22	13
	Mixed	377	79	13	8
Fettling shop	Iron	143	64	24	12
	Steel	398	47	19	34
	Mixed	122	62	25	13
Others	Iron	159	91	8	1
	Steel	221	84	12	4
	Mixed	237	90	9	1

X-ray category I—Normal
" " II—Early reticulation
" " III—Reticulation
" " IV—Nodulation and massive shadows

There are three broad groups, moulding shop, fettling shop and others. It will be seen that in all three groups the steel workers showed the highest incidence of abnormal X-ray changes. Further, in the steel group the highest incidence occurs in the fettling or cleaning processes. Again, it is in the fettling shop in all types of foundries that the highest incidence of X-ray abnormality is found. When these findings were correlated with age and length of exposure, much the same incidence was found in each group.

Dust counts taken in foundries show that the concentrations are highest and the dust particles smaller in the fettling processes. An exception to this general picture is that in iron moulding for small castings (not for large ones) the incidence of pneumoconiosis may be higher than in iron fettling. This fact is partly associated with the lavish use of silica parting powders, the use of which was prohibited in 1950, and partly with greater exposure to the dust of the knock-out.

The numbers of new cases diagnosed by the Pneumoconiosis Panels also gives an idea of what has been happening in the foundries. Table IV shows the numbers of new cases of pneumoconiosis in foundries for the years 1953, 1954 and 1955, listed under the various jobs.

These figures constitute an understatement of the real position, because of the 161 cases in 1953 more than half came from an area where there had been an X-ray survey of three iron foundries. It is certain that if more workers in other foundries had been X-rayed more cases would have been found. An accurate picture will not be obtained until all the workers undergo periodical clinical and X-ray examination. This observation applies, of course, to all dusty industries.

TABLE IV.—NEWLY DIAGNOSED CASES OF PNEUMOCONIOSIS FOUNDRY OCCUPATIONS*

Occupations	1953	1954	1955
Sand and shotblasting	6	5	8
Iron moulding	58	93	80
Iron dressing	23	23	23
Iron and steel dressing	4	11	4
Steel moulding	4	10	8
Steel dressing	37	13	7
Welding (electric and oxyacetylene)	10	11	13
Other and mixed foundry work ..	19	46	54
Totals	161	212	297

* Cases with significant dust exposures in other occupations have been omitted.

The problem of prevention of pneumoconiosis in foundries has been exercising the minds of many individuals and organisations in this country since about 1938. Progress in dust and fume control has been slow because of technical difficulties and the diverse conditions under which the work is done. It is also more difficult to apply up-to-date methods to an ancient and conservative trade than to a new one, and particularly when smoke and dust have been long held to have inherent virtues. It is a time-honoured saying in Sheffield, for instance, that " where there's muck there's money." But as a result of the work of three Joint Standing Committees set up by the Chief Inspector of Factories for steel, iron and non-ferrous foundries respectively, composed of representatives of employers, trades unions and the Factory Department, improvements in foundry conditions have gradually been made. The work is still going on and there is still much to be done. The new Iron and Steel Foundry Regulations (1954) came finally into force in January 1956. They are aimed, amongst other things, at the control of dust and fumes at all points where they are made, and in some cases to prevent dust being made.

The main cause of pneumoconiosis in foundries is the sand used for making moulds and cores. More castings are being made in metal moulds; and in Norway olivine (an aluminium silicate, the dust of which is much less fibrogenic than that of sand) is being used in some foundries. But it will not be possible for a long time to get rid of sand from British foundries. Many thousands of tons of sand are still being used each year. When I go into a foundry—and I have been in many both in this and other countries—I sometimes feel rather like the Walrus and the Carpenter in Lewis Carroll's *Through the Looking Glass:*

> The Walrus and the Carpenter
> Were walking close at hand:
> They wept like anything to see
> Such quantities of sand:
> "If this were only cleared away,"
> They said, "it *would* be grand."
>
> "If seven maids with seven mops
> Swept it for half a year,
> Do you suppose," the Walrus said,
> "That they could get it clear?"
> "I doubt it," said the Carpenter,
> And shed a bitter tear.

Fortunately, the outlook is not quite so sombre as the Carpenter seems to think, because there is now a real urge to make foundries less dusty and therefore more healthy.

Summary

1. The historical aspects of pneumoconiosis in foundry workers are briefly reviewed.

2. Foundry processes are described.

3. The pathology of foundry workers' lungs is discussed in detail with special reference to the distinction between classical silicosis and mixed dust fibrosis. Pneumoconiosis (silicosis and/or mixed dust fibrosis) is the main cause of death in foundry workers.

4. Other causes of death include tuberculosis, carcinoma of bronchus, pneumonia, bronchiectasis and coronary thrombosis. Chronic bronchitis and emphysema are commonly found. Emphysema is bullous, generalised or focal. Focal emphysema is more often seen with mixed dust fibrosis than with classical silicosis.

5. Reference is made to chemical analyses of the mineral content of foundry workers' lungs.

6. The X-ray appearances of silicosis and mixed dust fibrosis are described.

7. The incidence of pneumoconiosis is shown to be higher in fettling (or castings cleaning) shops than in other foundry workrooms, and higher in steel than in iron fettling shops. By contrast iron moulding shops show a higher incidence of pneumoconiosis than steel moulding shops.

8. The prevention of pneumoconiosis in foundry works is briefly discussed.

REFERENCES

Agricola, Georgius (1556): "De Re Metallica." Translated by H. C. Hoover and L. H. Hoover (1912). London: *Mining Magazine.*

Blasting (Castings and Other Articles) Special Regulations. S.I. 1949, No. 2225.

Brown, E. W., and Klein, W. E. (1942): *Nav. med. Bull. (Wash.)*, **40**, 42.

Fletcher, C. M., Mann, K. J., Davies, L., Cochrane, A. L., Gilson, J. C., and Hugh-Jones, P. (1949): *J. Fac. Radiol. (Lond.)*, **1**, 40.

Foundries (Parting Materials) Special Regulations. S.I. 1950, No. 1700.

Hamlin, L. E., and Weber, H. J. (1950): *Indust. Med.*, **19**, 151.

Harding, H. E., Gloyne, S. R., and McLaughlin, A. I. G. (1950): Chap. V in "Industrial Lung Diseases in Iron and Steel Foundry Workers," *loc. cit.*

—— and McLaughlin, A.I.G. (1955): *Brit. J. industr. Med.*, **12**, 92.

Holland, G. Calvert (1843): "Diseases of the Lungs from Mechanical Causes." London: John Churchill.

Iron and Steel Foundries Regulations. S.I. 1953, No. 1464.

Keatinge, G. F., and Potter, N. M. (1945): *Brit. J. industr. Med.*, **2**, 125.

—— and Harding, H. E. (1954): *Brit. J. industr. Med.*, **11**, 289.

Laënnec, R. T. H. (1819): "De l'Auscultation Médiate." Paris: J. A. Brosson and J. A. Chaudé.

McLaughlin, A. I. G., Cheeseman, E. A., Garrod, J., Gloyne, S. R., Goodall, K. L., Harding, H. E., Jupe, M. H., Lawrie, W. B., Perry, K. M. A., Sutherland, C. L., and Woods, H. (1950): "Industrial Lung Diseases of Iron and Steel Foundry Workers." London: H.M. Stationery Office.

—— and Harding, H. E. (1956): *A.M.A. Arch. industr. Hlth.*, **14**, 350.

Macklin, E. L., and Middleton, E. L. (1923): Report on Grinding of Metals and Cleaning of Castings. London: Home Office, H.M. Stationery Office.

Paracelsus (Theophrastus Bombast von Hohenheim) (1567): "Von der Bergsucht und anderen Bergkrankheiten." Dillingen: S. Mayer.

THE CONTRIBUTION OF THERAPEUTIC PROCEDURES TO AN EVALUATION OF DYSPNŒA IN PULMONARY EMPHYSEMA

By Alvan L. Barach

From the Department of Medicine
Columbia University College of Physicians and Surgeons, New York

Introduction

Definition of this clinical entity need not be extensively examined in this presentation, since I refer only to the illness recognised as chronic hypertrophic emphysema or diffuse obstructive emphysema, in which the lungs are over-filled with air, the smaller bronchi constricted, often, although not always, accompanied by bronchospasm, and the pulmonary parenchyma is itself abnormal in respect of its diminished volume response to the application of increased intrapulmonary pressures, " less compliant," especially in the latter part of inspiration and expiration. The " elastic " or recoiling pressure has been impaired, with a particularly damaging effect on the capacity of the bronchi to remain patent as the patient exhales—*i.e.*, the elastic pull on the bronchial wall that aids expiratory air flow is partially lost, with the result that premature collapse of bronchioles may take place before all the inhaled air is delivered to the outer atmosphere (Dayman, 1956). Alveolar over-distension then is followed by enlarged air sacs with impaired capillary blood supply and inefficient ventilation.

Bullous formation is more apt to occur at the periphery of the lungs, which are immediately exposed to stretching inspiratory pressures. It is not often realised that the parts of the lungs distant from the expanding thorax, such as those near the hilum, are generally in much better shape, both from the standpoint of perfusion with blood as well as anatomically better parenchyma; nor is it generally acknowledged that increasing the excursion of the diaphragm relieves dyspnœa largely because of selective ventilation of more intact lung tissue.

This discussion is mainly concerned with the effects of physical procedures that modify the volume of the pulmonary ventilation and the quality of the ventilatory process, including especially the response to posture, manual and mechanical expiratory chest compression and pressure breathing. When a decrease in the total volume of respiration is produced by measures which increase the efficiency of exchange of oxygen as well as carbon dioxide, the consequent relief of dyspnœa may be based on a lessening of such pathophysiological states as alveolar over-distension, impaired expiratory air flow, premature bronchial closure, hypoxia, pulmonary congestion and diminished elastic recoil of the lungs. The selection of the topics discussed is admittedly incomplete.

Dyspnœa, as here considered, refers to the subjective experience of difficult

(*Received for publication March* 30, 1957.)

breathing. Although it may be detected by observation or appraised by tests of respiratory function, shortness of breath may not be present even when gross abnormalities may be observed by physical examination or laboratory tests (*cf.* Miller, Fowler and Helmholz, Meneely and Callaway, Alexander, Riley, 1956).

Response to Oxygen Inhalation

Since the object of this inquiry into the mechanism of dyspnœa in pulmonary emphysema is to utilise the response to certain therapeutic procedures, it seems especially pertinent to stress that the chemoreceptors are exquisitely sensitive to variations in oxygen tension (Winterstein, 1911). This is revealed clinically by the abrupt diminution in pulmonary ventilation when the patient breathes 100 per cent. oxygen as a test of the presence or absence of pulmonary emphysema. An instantaneous decrease of approximately 20 per cent. in pulmonary ventilation generally takes place in patients who reveal other mani-

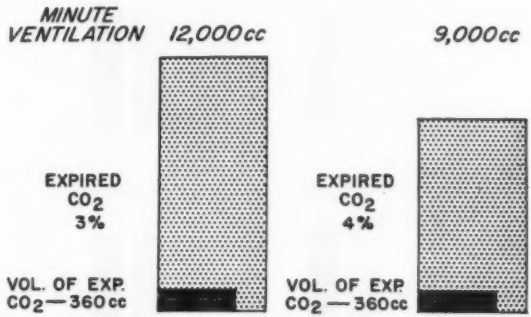


Fig. 1.—Equal elimination of CO_2, during a decreased minute ventilation, achieved by increase in expired CO_2 percentage.

festations of the disease; this response constitutes confirmatory evidence of the presence of "diffuse obstructive pulmonary emphysema." Retention of carbon dioxide takes place under these circumstances, and, if the inhalation of 100 per cent. oxygen is prolonged, the *p*H shifts to the acid side in a period of one-half to two hours, depending upon the extent of the disease. In clinical treatment, low, gradually increasing concentrations of oxygen are administered to permit compensatory retention of base to take place, which is one of the homeostatic mechanisms responsible for elimination of CO_2 at a diminished volume of breathing (Barach, Richards, 1956). In Fig. 1 a schematic drawing illustrates the way in which an equal CO_2 production may be exhaled by a higher CO_2 percentage in the expired air. It will be seen that a reduction of minute ventilation from 12,000 c.c. to 9,000 c.c. per minute was accomplished by oxygen inhalation with maintenance of the same CO_2 output, 360 c.c. per minute. The increased CO_2 in the expired air, from 3 per cent. to 4 per cent., thus served to decrease the work of breathing; the relief of dyspnœa is evidence of the utility of the homeostatic mechanism, as shown in this schematic illustration.

Effects of Posture on Respiratory Function

When a patient with pulmonary emphysema is placed in a head-down position, in which the thorax is tilted headward approximately 15 to 20 degrees, institution of diaphragmatic breathing is observed by inspiratory protrusion of the abdomen as well as by fluoroscopic observation. Under these circumstances the pulmonary ventilation may also decrease 20 per cent., but without retention of carbon dioxide or acid shift in *p*H (Barach, Beck, Bickerman, 1956). At the same time the arterial oxygen saturation is either maintained at its previous level or may be slightly increased. The illustrations here presented reveal that a more effective alveolar ventilation has been initiated; both the consumption of oxygen and the minute volume of breathing

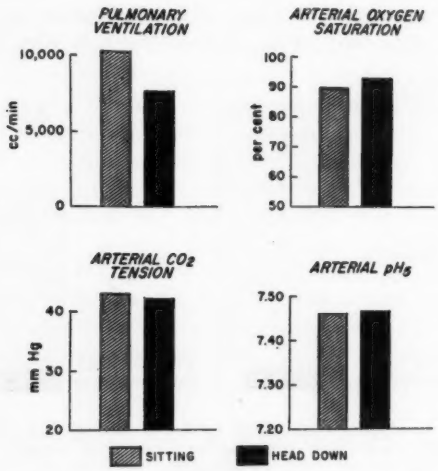
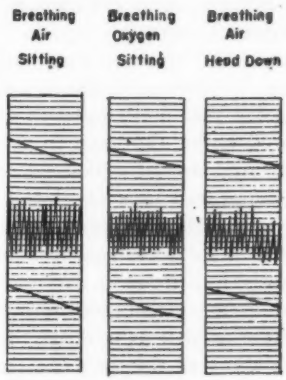


Fig. 2.—Data calculated from: Barach, A.L., and Beck, G. J.: The ventilatory effects of the head-down position in pulmonary emphysema. (*Amer. J. Med.*, **16**, 55, 1954.)

have been lowered. Exchange of oxygen and CO_2 takes place with a lower unit volume of ventilation. In Fig. 2 the averaged results in ten patients in whom diaphragmatic breathing was initiated by the head-down position reveal that a 25 per cent. lowering of the ventilation was accompanied by an arterial oxygen saturation and *p*H as high as or slightly higher than that found with a higher ventilation in the sitting-erect posture. The average arterial CO_2 tension was only slightly lower. In Fig. 3 the total ventilation of a hypoventilating patient, as well as the O_2 consumption, was lower in the head-down position, 6,200 c.c. to 4,500 c.c. and 340 c.c. to 170 c.c. per minute respectively. This response, according to our hypothesis, is because diaphragmatic breathing results not only in enhanced ventilation of the lower lobes of the lung but also of areas of the lungs near the mediastinum. The lung parenchyma in patients with pulmonary emphysema is more normal in this region, in respect of

preservation of the integrity of the alveoli as well as the pulmonary capillary circulation, than in areas of the lung at the periphery in which alveolar overdistension frequently results in the formation of bullæ and loss of capillary circulation.

The decrease in pulmonary ventilation revealed in Fig. 3 was found to be greater in the head-down position than during inhalation of 100 per cent. oxygen, accompanied by a striking decrease in oxygen consumption. In this case the pulmonary ventilation was far lower than that ordinarily found; it represented one of the more unusual instances of drowsiness and low pulmonary ventilation. The arterial CO_2 was 65 mm. Hg, and the *p*H of the



	Breathing Air Sitting	Breathing Oxygen Sitting	Breathing Air Head Down
Pul. Vent. cc/min	6200	5300	4500
O_2 Con. cc/min	340	230	170
Tid. Air cc	390	330	330
R. Rate per min	16	16	14

FIG. 3.—Ventilatory changes induced by posture and breathing 100 per cent. oxygen.

arterial blood was 7·41, at the time the spirometric record was taken; he was then recovering from a severe uncompensated CO_2 acidosis.

When the lung volume is decreased during ordinary expiration the diameter of the bronchi is also decreased. However, bronchioles and alveolar ducts appear to transmit air to and from the alveoli more effectively in the head-down position. The relaxation pressure of the lung is naturally increased as a result of the pressure of the viscera headward; in addition, reserve diaphragmatic respiration is increased in the presence of a decreased functional dead space. Finally, it is suggested on theoretical grounds that the centripetal pressure of the lung parenchyma on the outside walls of the bronchioles and alveolar ducts maintains them in a more patent position; increased lung recoil tends to

prevent premature bronchial closure and the check valve mechanism (Dayman, 1956).

Our studies indicate that the head-down position when employed in patients with pulmonary emphysema generally results in a remarkable transformation of both the objective and subjective evidence of dyspnœa.

The patient is induced to lie head-down only after providing him with a complete explanation of what is going to happen. He is then gradually tilted until diaphragmatic breathing takes place. If he is on a soft bed, a board must be placed under the mattress or several pillows under the trunk, until the shift in position from the trunk to the head results in sufficient pressure on the viscera to initiate an upward pressure on the diaphragm. It may then be observed that the diaphragm contracts during inspiration and that the volume of ventilation is diminished progressively less.

If the patient does not spontaneously stop movements of the shoulder girdle and upper chest he is encouraged to use the diaphragm alone by such simple instruction as : " You don't need to raise your shoulders any more." Two pillows are placed under the head to avoid flushing of the face and the patient is quietly observed until the desired result is made manifest. At first the hand of the physician and later the hand of the patient is placed on the abdomen in order that he should be aware that protrusion of the abdomen indicates that he has now successfully accomplished diaphragmatic breathing. He is also told to breathe as little as he can and not as much as possible. When the initial control pulmonary ventilation is obtained in the sitting-erect position he is also told to breathe as little as possible. These instructions are outlined in detail in an essay as short as this because the author has become aware of studies in which the patient has been abruptly tilted headward with no provision made to maintain his comfort or freedom from apprehension at the suddenness with which it is done. Negative results found under these circumstances bear no relation to the procedure itself but rather to the manner in which it was carried out.

Effects of Pressure Breathing, Circulatory and Ventilatory

Before presenting our more recent studies on mechanical ventilation, some of the ventilatory and circulatory responses to pressure breathing will be reviewed.

In cases with cardiac failure, dyspnœa is produced by the sudden rush of blood into the lungs when the thorax is tilted headward. In borderline cases it will often be observed that the patient will purse his lips during expiration as if to maintain a certain degree of expiratory positive pressure breathing to prevent inlet of blood into the right heart; it is our hypothesis that this does in fact take place, since the peripheral venous pressure has been shown to be substantially elevated by expiration conducted through pursed lips (Beck and Barach 1957). The intercostals and the abdominal muscles are then markedly contracted as air is exhaled from the lungs through this type of patient-controlled pressure breathing. When dyspnœa is relieved under these circumstances by pursed-lip breathing, the procedure appears to be utilised in part as a method of preventing pulmonary congestion; at any rate, it diminishes the sensation of

difficult breathing. It has long been noted that pursed-lip breathing is employed in patients with pulmonary emphysema during the exertion, as indeed it is in normal subjects who engage in mountain climbing or who do strenuous types of exercise—*i.e.*, the lumbermen in Canada and the men who break rock in Italy. Entrance of the blood into the heart may be retarded as a mechanism similar to that which has previously been demonstrated in animals and human subjects during pressure breathing, the degree of blockade and the decrease in cardiac output varying with the mean pressure applied.

Among the clinical effects of pressure breathing, when the mean pressure is above that of the atmosphere, produced by either continuous, expiratory or inspiratory intermittent positive pressure breathing, is relief of the dyspnœa of cardiac insufficiency, either in the milder form which manifests itself on exercise or in more severe left ventricular failure accompanied by œdema of the lungs. The patient with pulmonary emphysema who spontaneously employs pursed-lip breathing on exercise has come to use it, it would seem, through some instinctive selection of a physiologically advantageous behaviour.

Among the other effects of supra-atmospheric continuous pressure breathing is the dilatation of the bronchi that takes place along with enlargement of chest volume (Swenson and Barach; Bickerman). Widening of the diameter of the smaller bronchi results in improved ventilation of the alveoli, decreased respiratory effort and decreased dyspnœa.

The lung volume is increased when patients with pulmonary emphysema lean forward; there is also a diminished downward pull of the viscera on the diaphragm. The total pulmonary ventilation under these circumstances may be little altered, even with the increase of the dead space, but a sensation of decreased dyspnœa is characteristically experienced as diaphragmatic movement is enhanced. In patients who at the same time wear a suitable belt a lowering of the total pulmonary ventilation has been observed.

Continuous positive pressure breathing is employed either with a mask which maintains 6 cm. to 8 cm. H_2O pressure in inspiration and expiration, or by means of a chest jacket or a box in which the head is outside, the thorax inside, exposed to a continuous negative pressure of 6 cm. to 8 cm. H_2O. During treatment an increase in mid-expiratory air flow was demonstrated, accompanied by decreased dyspnœa in most cases of pulmonary emphysema and bronchial asthma. This decrease in the effort of breathing is related in part to the fact that the inspiratory positive pressure tends to force air into the lungs and the expiratory positive pressure maintains a larger diameter of the smaller bronchi. An increased velocity of air flow during the natural and mechanically induced cough was found when the bronchi were dilated by this procedure as well as by broncho-dilating drugs (Beck and Barach).

Manual and Mechanical Augmentation of Reserve Volume Respiration

Manual expiratory compression of the lower thorax has long been employed as a method of reducing over-distension of the lungs of the emphysematous patient as well as aiding the propulsion of secretions from the smaller bronchi to the upper respiratory passageway. Measurements of the function of the lungs in terms of expiratory air flow and trapping of air indicated that a favourable

effect was thereby produced—*i.e.*, a higher mid-expiratory air flow and less trapping of air after the procedure.

More recently a pneumatic breathing aid has been developed in our clinic in which similar effects were produced by a pneumatic jacket attached to the lower lateral thorax and extending 3 inches in front of and behind the axillary margin (Barach, Beck and Smith).

When a sensing device was used in which the expiratory flow of air from the outer nares produced (through a Thermistor) an electrical contact that activated a pump, compression of the ribs resulted in an increase of tidal volume,

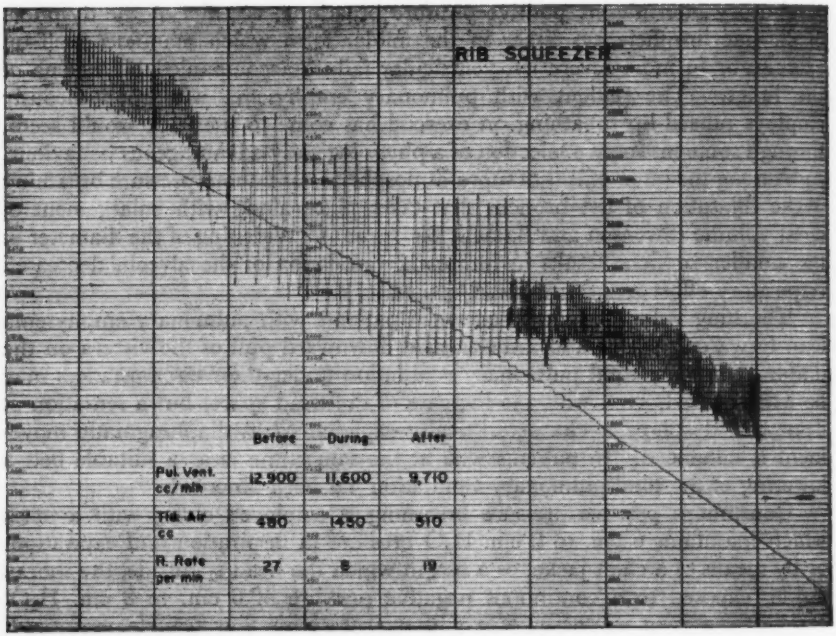


FIG. 4.—Decrease in pulmonary ventilation associated with increased tidal air produced as a result of mechanical increase in reserve volume respiration.

100 c.c. to 500 c.c., with a uniform decrease in respiratory rate. The total pulmonary ventilation was decreased in some cases, which was evidence of the greater efficiency of ventilation achieved by promoting increased aeration of the functional residual air. Increased expiratory air flow, found in some cases after treatment, was interpreted as due to diminished alveolar over-distension.

In Fig. 4 the response of a case of pulmonary emphysema to the rib-squeezing apparatus is illustrated. It will be seen that an increase of tidal air from 480 c.c. to 1,450 c.c. resulted in the patient reducing his respiratory rate from 27 to 8 and pulmonary ventilation from 12,900 c.c. to 11,600 c.c. per minute. The relief of dyspnœa achieved by manual or mechanical chest compression, together with the results of functional testing, indicated the importance of distension of the lung as a factor in the production of dyspnœa

in cases of pulmonary emphysema. Alveolar over-inflation represents, of course, a pathophysiological state in which many contributory factors participate in the production of dyspnœa—*e.g.*, impairment of pulmonary elasticity and air flow, hypoxia and CO_2 retention.

The Patient's Ventilatory Response

When patients with pulmonary emphysema manifest a normal or nearly normal arterial oxygen saturation, a burdensome degree of heightened volume of breathing is generally maintained, with the result that the arterial oxygen saturation is likewise maintained at or nearly at the normal level. When dyspnœa is relieved by some of the procedures mentioned, *the arterial saturation may also be found at the same level that it was prior to treatment but at a lower volume of ventilation.*

Thus, in patients with pulmonary emphysema who have, for example, an arterial oxygen saturation of 88 per cent., tilting the patient's thorax toward the head to produce diaphragmatic breathing may result in a decrease in ventilation of 25 per cent., but the arterial oxygen saturation is found to be still 88 per cent. With the use of the pneumatic breathing aid that results in increased reserve respiration and increased tidal air, there is in some cases a decreased total ventilation. The arterial oxygen saturation may remain the same, but the diminution in total pulmonary ventilation results in relief of dyspnœa. It would appear that dyspnœic patients at times maintain the oxygen and CO_2 tension of the blood constant and take advantage of the decreased dyspnœa provided by the more efficient and lower pulmonary ventilation. To put it another way, had the patient preserved during treatment the original volume of breathing (hyperventilation) the exchange of oxygen and carbon dioxide might presumably have been increased by reason of the more efficient method of breathing provided. However, when the effectiveness of alveolar ventilation has been increased, by the head-down position or as the result of increasing aeration of the functional residual air by manual or mechanical expiratory thoracic compression, a lowering of the total pulmonary ventilation is often found; the patient acts as if he prefers freedom from dyspnœa to what might otherwise be a more favourable alteration in respiratory function, such as a restoration of a normal arterial oxygen saturation.

Although inhalation of high concentrations of oxygen produces an uncompensated respiratory acidosis, the patient who has received gradually increasing concentrations of oxygen may become adapted to a high tension of carbon dioxide which in itself permits a decrease in the volume of breathing of such an extent as to relieve dyspnœa. In fact, the alveolar and expiratory CO_2 has been found to be far above the normal level without the patient being narcotised or uncomfortable, since the device of excreting carbon dioxide with a small volume of breathing in itself prevents an uncompensated respiratory acidosis—*i.e.*, acid shift in blood *p*H.

A similar response, namely the patient's selection of a lowered pulmonary ventilation and relief of dyspnœa instead of increased ventilation and restoration of a more normal oxygen saturation, has also been observed in cases of poliomyelitis with breathing difficulties.

A characteristic response to acute hypoxia is an increased pulmonary ventilation, both in normal human beings and those with pulmonary emphysema. Similarly, inhalation of carbon dioxide results in an increased volume of inhalation, even in patients with pulmonary emphysema; the decreased response to inhalation of 5 per cent. CO_2 has recently been shown to be due to limitation in their maximal breathing capacity rather than to impairment of the sensitivity of the respiratory centre; a similar degree of limitation in maximal minute ventilation when produced by obstructive respiration imposed on normal subjects resulted in a comparable decrease in ventilation during inhalation of 5 per cent. CO_2 (Cherniak).

When analysis of the arterial blood gases is made in patients with emphysema, the findings do not consistently indicate the cause of dyspnœa (Fowler *et al.*), but patients with a normal oxygen saturation are, however, relieved of dyspnœa with a prompt decrease in pulmonary ventilation when oxygen is inhaled. In addition, presence of increased tensions of CO_2 in the blood may also be found in an individual whose ventilation is not increased to the point of dyspnœa. Hyperventilation does take place as a response to lack of oxygen and as a response to increased resistance in the respiratory passageway. It is not our purpose here to discuss the complexity of the response to oxygen, carbon dioxide or change in *p*H; a review of this subject is that of Winterstein. Our interest in this problem at present is the degree of ventilation selected by the patient when offered the opportunity for relief of dyspnœa by mechanical augmentation of respiration. With the use of the sensing device referred to above, clinical and physiological studies have been planned to contribute information on this problem.

REFERENCES

BARACH, A. L., and BICKERMAN, H. A. (Editors) (1956): "Pulmonary Emphysema." Baltimore (Baillière Tindall & Cox, London*). Contributors: Alexander, James K.; Beck, G. J.; Callaway, James J.; Cherniak, Reuben M.; Dayman, Howard G.; Deterling, Ralph A., Jr.; Fishman, Alfred P.; Fowler, Ward S., Helmholz, H. Frederic, Jr.; Knight, Vernon; Levine, Edwin R.; Meneely, George; Miller, R. Drew; Richards, Dickinson W., Jr.; Riley, Richard L.; White, Arthur C.

BECK, G. J., and BARACH, A. L. (*In the press.*)

WINSTERSTEIN, H. (1911): *Pflugers Arch. ges. Physiol.*, **138**, 167.

* Fuller details of references are to be found in this book.

PLEURAL NEOPLASMS

By Joseph Smart and K. F. W. Hinson

From The London Chest Hospital

Historical and Literature

The occurrence of malignant tumours apparently arising from the pleura has been known for many years. The earliest report appears to have been by Joseph Lieutaud (1767), quoted by Nelson, which was of a pleural tumour in a boy. Laennec (1819) refers to "cancer of the pleura" and describes the typical syndrome associated with pleural neoplasms. Hache (1834) described a tumour arising in the pleura wrapping itself around the heart, which would appear from the history to have been a benign tumour, possibly a lipoma. Ayrolles (1884) described a typical case of pleural neoplasm, fluid having to be removed frequently from the left chest, the post-mortem showing that the left pleura contained a blood-stained effusion, the pleura being about half a centimetre thick and there being elastic fibres and connective tissue infiltrated with small round cells. Nothing was found in the lung itself.

The first case recorded in this country appears to have been one by Collier (1885), and subsequently others have been reported in small numbers from many countries by Charcelay (1836), Musset (1850), Pitt (1887), Saundby (1889), Biggs (1890), Benda (1897), Butler (1898), Adler (1901), Delafield (1902), Bassoe (1903), Delatour (1903 and 1908), Meslay and Lorraine (1903), Lewis (1905), Ravenna (1905), Miller, James and Wynn (1908), Sprunt (1911), Lesieur, Savy and Mazel (1913), Clarkson (1914), Keilty (1917), Du Bray and Rosson (1920), McDonnell and Maxwell (1920), Eastwood and Martin (1921), Freeman (1921), Wessler and Jaches (1923), Heuer (1924), Robertson (1924), Gaarde and Sutherland (1925), Lord (1925), Criep (1927), Heise and Trudeau (1927), MacMahon and Mallory (1928), Ley (1929), Sala (1930), Klemperer and Rabin (1931), Hashiba, Cowan and Nixon (1932), Lindqvist and Bergstrand (1932), Montague (1932), Banyai and Grill (1933), Zohlen (1934), Geschickter (1936), McDonald (1936), Vitkus (1937), Barrett and St. C. Elkington (1938), Birnbaum (1938), Hochberg (1939 and 1951), Harvey, Dawson and Innes (1940), Gerundo (1941), Doub and Jones (1942), Klemperer and Tedeschi (1942), Fourestier and Duret (1943), Saccone and Coblenz (1943), Postoloff (1944), Hochberg, Epstein and Pernikoff (1947), Barlas (1954), Tobiassen (1955), Bogardus, Knudtson and Mills (1955), Chaptal, Campo, Jean and Campo (1956), Boddaert (1956), Banerjee and Dey (1956).

This paper deals with the diagnosis and treatment of this condition together with the autopsy findings, and ends with a discussion on the ætiology of pleural neoplasms.

The Clinical Syndrome

Owing to the rarity of these tumours it is difficult to arrive at the exact ætiology. The presenting clinical features are well known—*i.e.*, dyspnœa

(*Received for publication May* 6, 1957.)

sometimes associated with mild pleuritic pain which is occasionally severe, slight cough (though this is not a marked feature), and loss of weight in the later stages of the disease. There is usually no hæmoptysis. While the tumours may occur in patients of any age, they are found more frequently in older people. The youngest recorded case is that of a girl of six (Chaptal, Campo, Jean and Campo, 1956). On clinical examination a pleural effusion is found on one side, and the fluid, when aspirated, is a clear straw-coloured fluid at the beginning of the disease. In the early stages the cytology seldom helps with regard to the diagnosis, although occasionally endothelial cells are present in fairly large numbers. The subsequent course of the disease is one of continued fluid formation, this gradually becoming blood-stained, necessitating frequent tapping for the comfort of the patient. In the later stages large quantities of fluid may need removing at short intervals, but the relief is not marked in the terminal stages, whereas at the onset it is. The general condition of the patient during the initial stage of the disease remains remarkably good. There is little loss of weight or anorexia, the hæmoglobin and blood count remain practically normal, but sometimes there is dyspnœa due to the fluid. The general state of well-being often persists even when the fluid has become heavily blood-stained, and is in marked contrast to the general condition of a patient with neoplastic changes occurring elsewhere. Radiologically, at the beginning, a pleural effusion only is seen, but subsequently the pleura becomes thickened and irregular, particularly on the parietal side, while the visceral pleura also becomes thickened but is not so nodular. This is easily demonstrated by air-replacement and further X-rays. There is nothing abnormal to be seen in the pulmonary tissue itself, and on bronchoscopy the bronchial tree is found to be normal, apart from displacement due to the effusion. After air-replacement the pleura may appear to be normal, but even if tumours can be seen radiologically, thoracoscopy should be performed in order to establish the histology of the tumour, and in cases where the pleura appears to be normal radiologically, on inspection by thoracoscopy it is not infrequently seen to be studded with small tumours, biopsy of which will give the histological diagnosis. At times the growth may extend from the pleural cavity, where it involves the diaphragm on its upper surface, and invade the peritoneal cavity and also the pericardium on the left side. Secondary deposits may rarely occur, usually in the axilla, but are not limited to this region. There is no curative treatment because of the widespread nature of the disease, but symptomatically it is possible, by radio-active gold, given intra-pleurally, to retard or often stop the formation of the fluid, though this seldom absorbs. The general tendency, as previously stated, is for the patient to remain relatively well until the terminal stages of the disease, when there is a gradual downhill course, with loss of weight and increasing dyspnœa leading ultimately to death. The average duration of life from the time of diagnosis is about eighteen months.

Treatment

Until recently there has been no possible treatment for these cases, but with the introduction of radio-active gold it is possible to relieve the patient's symptoms very considerably. Radio-active gold is inserted into the pleural fluid and the patient is then tipped so that the effect is distributed as equally as

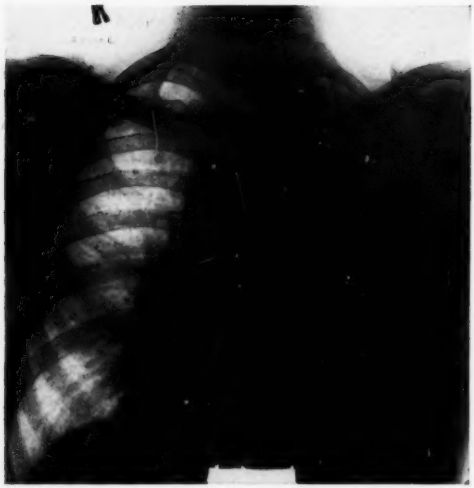


FIG. 1.—Showing large pleural effusion on left side.

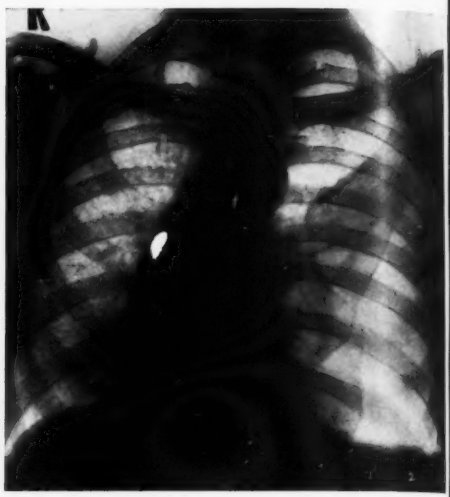


FIG. 2.—Showing hydro-pneumothorax on left side following air-replacement, with adhesion of the lung to the chest wall, but no evidence of pleural involvement.

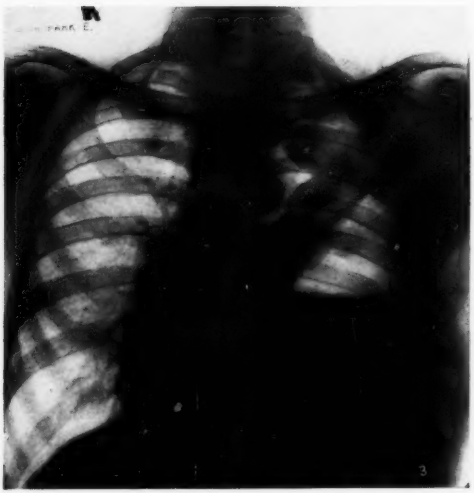


FIG. 3.—Showing the same patient 7 months later with hydropneumothorax and large secondary deposit on the pleura.

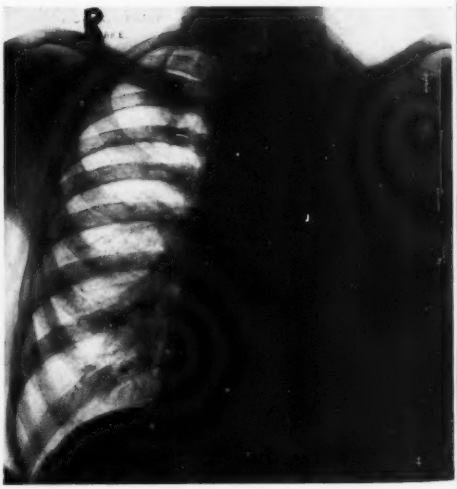


FIG. 4.—Showing the same patient following the insertion of radio-active gold. The left side is blacked-out with fluid, but the mediastinum is not displaced and fluid is not forming.

To face p. 321

possible over the pleura. This causes material diminution in the rate of fluid formation but is, of course, not curative. We have treated ten patients in this way and in all except one the rate of fluid formation was greatly reduced. In each case 100 millicuries of radio-active gold was introduced into the pleural cavity. This caused slight general malaise with a mild pyrexia of 100°-101° for one or two days, with some tightness of the chest and slight pain for three or four days. The radio-activity of the gold lasts for approximately ten days, but in the latter part of this time the irradiation given off is minimal. It is, however, important to remember that if fluid is to be drawn off during the first week to ten days, great care must be taken with regard to its disposal because of the radio-activity.

It is of interest to note that in our series the incidence of pleural neoplasms is much more frequent on the right side than on the left. In the ten cases treated by radio-active gold, eight were on the right side and only two on the left, and in one case the fluid was bilateral (Figs. 1, 2, 3, 4).

Differential Diagnosis

The differential diagnosis of this condition in the early stages is very difficult, and includes all diseases in which a pleural effusion may occur, such as acute and chronic infections of the lung, but in these cases there is usually X-ray evidence of pulmonary involvement, or the cytology of the fluid suggests the effusion is tuberculous or of other infective origin. Tubercle bacilli can often be obtained from the fluid in the tuberculous cases, but, on the other hand, tuberculous pleural effusions can be extremely difficult to differentiate at times, particularly in cases where the fluid becomes loculated so that it causes an apparent uneven thickening of the pleura, but the diagnosis can be established by direct inspection of the pleura through a thoracoscope. Pulmonary neoplasms giving rise to pleural effusion, which may be chronic in character and associated with some pleural thickening, can usually be differentiated with a fair degree of accuracy with our present knowledge. Firstly, the history is often suggestive because cough and hæmoptysis are common symptoms in a pulmonary neoplasm, but are uncommon in pleural neoplasms. Secondly, the radiological appearances of the lung may suggest a lesion within it, and thirdly, bronchoscopy will frequently demonstrate the presence of a tumour unless it is peripherally situated. The presence of neoplastic cells is frequently demonstrated in the sputum. The absence of cough, sputum and hæmoptysis is a very constant feature of pleural neoplasms. Rarely, chylous effusions may come into the differential diagnosis, but in these cases the cytology and biochemistry of the fluid will also settle the diagnosis.

In the rare cases of tuberculous disease of the spine, pus may track round to the pleura, which must also be remembered, but this can be shown by X-ray of the spine.

Case Reports and Clinical Investigations

This series of pleural neoplasms comprises 24 cases, 13 male and 11 female. The youngest was a man of 31 years of age and the oldest a woman of 72 years of age. Histological evidence of the nature of the growth was available in 22

of the 24 cases. In the other 2 cases there was radiological evidence of pleural involvement. Ten of these cases were treated with radio-active gold, given intrapleurally. A brief typical clinical history and the result of the investigations is given.

TABLE I

(Cases 1-10 treated with radio-active gold.)

Case	*Age*	*Sex*	*Side*	*Diagnostic Features*
1	55	M	L	Thoracoscopy showed nodules on pleura. Biopsy: indefinite. Thoracotomy. Biopsy: " neoplastic." P.M.: parietal and visceral pleura and left apex involved.
2	64	M	R	Thoracotomy. Biopsy: " carcinoma."
3	40	F	R	Thoracoscopy showed nodules on pleura. Biopsy: " adeno-carcinoma."
4	37	F	R	Thoracoscopy showed nodules on pleura. Biopsy: " undifferentiated carcinoma."
5	69	M	R	Thoracoscopy showed nodules on parietal pleura. Biopsy: " adeno-carcinoma." P.M.: pleural involvement secondary to carcinoma of prostate.
6	55	F	L	Thoracoscopy showed nodules on pleura. Biopsy: " undifferentiated carcinoma."
7	48	M	R	Thoracoscopy showed plaques on pleura. Biopsy: " carcinoma."
8	54	M	R	Thoracoscopy showed nodules on pleura. Biopsy: " adeno-carcinoma."
9	45	M	R	Thoracotomy. Biopsy: " adeno-carcinoma."
10	72	F	R	Thoracoscopy. Nodule on parietal pleura. Biopsy: indefinite. P.M.: pleural involvement secondary to carcinoma of stomach.
11	60	M	R	Plaques on visceral and parietal pleura at thoracoscopy.
12	68	M	R	X-ray evidence of nodules on pleura.
13	32	F	R	Thoracoscopy. Biopsy: " squamous carcinoma."
14	31	F	R	Thoracoscopy showed nodules on pleura. Biopsy: " neoplasm."
15	62	M	L	Thoracoscopy showed nodules on pleura. Biopsy: " undifferentiated carcinoma."
16	67	M	L	Thoracoscopy showed nodules on pleura. Biopsy unhelpful.
17	44	F	L	Thoracoscopy showed nodules on pleura. Biopsy: " neoplastic." P.M.: carcinomatosis of left lung.

TABLE 1—*continued*

Case	*Age*	*Sex*	*Side*	*Diagnostic Features*
18	52	F	R	Thoracoscopy showed nodules on pleura. Carcinoma of rectum excised thirteen years previously.
19	57	M	R	Pleural biopsy: "adeno-carcinoma."
20	47	F	R	Biopsy of right scalene node: "carcinomatous tissue." Carcinoma of left breast and radiotherapy two years previously.
21	58	M	R	Thoracotomy. Biopsy: "carcinoma."
22	46	F	R	Thoracotomy. Biopsy: "carcinoma." Carcinoma of left breast and radiotherapy nine years previously.
23	61	F	R	Thoracotomy. Biopsy: "lymphatics permeated by carcinoma." Carcinoma of left breast and radiotherapy thirteen years previously.
24	59	M	R	Thoracotomy. Biopsy: "adeno-carcinoma."

Table 1 tabulates the total series, giving the diagnostic features and biopsy reports of pleural neoplasms or the post-mortem findings when these are available. Nineteen cases occurred on the right side and 5 on the left. In 2 cases evidence of fluid and pleural involvement occurred on both sides terminally. They are included in the table above, where the side on which the fluid first developed is recorded.

Table 2 shows in tabular form the cases receiving radio-active gold and the frequency of tapping before and after treatment. There was marked improvement in all cases except one, in which the fluid was forming so rapidly that it had to be taken off before the radio-active gold had had time to irradiate the pleural mucosa. This patient died shortly afterwards.

TYPICAL CLINICAL HISTORY

A woman aged 37 who in November 1953 developed a right pleural effusion which was treated by bed rest and repeated aspirations. The fluid contained lymphocytes and on one occasion numerous clumps of degenerate cells were seen, ?malignant. The culture was negative for acid-fast bacilli and guinea-pig inoculation was also negative. The fluid continued to accumulate, with a high, swinging temperature. She was given streptomycin, 1 g. daily for seventy days, with INAH. On 14.5.54 she was admitted to the London Chest Hospital with cough following a cold and pyrexia. On examination her general condition was good, there were signs of a right pleural effusion with marked mediastinal displacement. There were no other abnormal physical signs. The X-ray of her chest showed a large right pleural effusion. She was febrile, the temperature rising to 100·4° in the evening. Her blood count showed Hb: 97%; W.B.C.: 14,800. The Mantoux to 1/1,000 was positive. Gastric lavage was negative for tubercle bacilli on culture. The fluid was slightly turbid, sterile on culture, containing many endothelial cells, a fair number of polymorphs and a small number of lymphocytes. Acid-fast bacilli and malignant cells were not found. Tomograms

taken on 27.5.54 showed some small nodules on the parietal pleura and large ones at the apex. She was thoracoscoped on 16.6.54 and the biopsy showed that this was an undifferentiated neoplasm. Bronchoscopy was performed on 28.6.54, but no abnormality was seen. On 7.7.54 and 11.8.54 she was given 100 millicuries of radio-active gold intrapleurally. Before treatment she had to be aspirated at three-weekly intervals, but after treatment no aspirations were necessary. The patient died on 1.3.55, but no post-mortem was obtainable.

TABLE 2.—PATIENTS TREATED WITH RADIO-ACTIVE GOLD INTRA-PLEURALLY

Case	*Age*	*Sex*	*Side*	*Months from onset of symptoms to gold*	*Histology*	*Frequency of aspirations (approx.)*	
						Before gold	*After gold*
1	55	M	L	15	Pleural neoplasm	Twice weekly	Twice weekly
2	64	M	R	10	Extension from a carcinoma	Weekly	3 weekly
3	40	F	R	7	Carcinoma, probably adenoma	5 weekly	nil
4	37	F	R	9	Undifferentiated neoplasm	3 weekly	nil
5	69	M	R	19	Malignant tumour suggestive of adenoma	2 weekly	nil
6	55	F	L	13	Undifferentiated carcinoma	3 weekly	nil
7	48	M	R	6	Carcinoma	4 weekly	nil
8	54	M	R	5	Malignant tumour, probably adenoma	weekly	once in 4/12
9	45	M	R	4	Adenocarcinoma	once only	nil
10	72	F	R	2	—	weekly	nil

None of these people were known to have had a pleural effusion before.

Discussion

The origin of these tumours, which often appear both clinically and at post-mortem to be primary tumours of the pleura, has given rise to considerable discussion. Lewis (1923) discusses the embryological changes in cells and

comes to the conclusion that the endothelium is derived from the primitive mesoderm, but that the mesothelium is in the nature of a transformation in the form of the cells due to environment, and in tissue cultures from the heart of chick embryos, observes the changing of these cells from multipolar cells into mesothelial cells. Schuyler Pulford (1925) also discusses the ætiology of tumours arising from blood and lymph channels, and he is of the opinion, from embryological evidence, that the mesoderm arises from the primitive embryonic ectoderm, extending laterally from the primitive streak between the ectoderm and endoderm, and goes on to suggest that if this tissue becomes malignant it may produce epithelial tissue such as a carcinoma or mesodermal tissue such as a sarcoma. He points out that of the two theories of blood-lymph origin, the angioblast theory of His and the theory of local origin, the latter assumes that the mesenchyme may change into blood and lymph tissue and is not of direct descent from the angioblastic endothelium. It is upon this basis that he suggests that malignancy arising from mesenchyme tissue will form carcinoma or sarcoma. Robertson (1924) reviews the literature and describes further cases, but suggests that these tumours are all secondary deposits in the pleura, possibly from a small primary in the lung. In 1928 Young attempted to investigate malignant tumours of the pleura by injecting an inoculum of Sudan III, olive oil and sodium tauroglycocholate into the pleura of rabbits. This was used because Fischer (1906), quoted by Young, had shown that the fat-soluble dyes and an injection of olive oil saturated with scharlach R, when injected into rabbit's ears, produced epithelial proliferation and keratinisation, resembling squamous epithelioma. The injecting of this inoculum into the pleural cavity showed changes in the endothelium with endothelial cells, columnar cells and squamous cell formation, including prickle cells, and also the formation of cystic swellings which were lined by both endothelial and columnar cells, the transition from one to the other being gradual. He interpreted this as epithelial formation on the surface of the pleura developing from the endothelium by metaplasia, but points out that it may have occurred from pricking of the lung at the time of the injection, and be an outgrowth of alveolar epithelium. Klemperer and Rabin (1931) discuss the question of primary neoplasms of the pleura, reporting five cases, in which there were epithelial cells in nests or rows, giving the appearance of fibroblasts, which in other places were markedly flattened, together with large polygonal cells with abundant cytoplasm. They thought that these tumours were primarily pleural tumours, and refer to the work of Maximow (1927), who had shown by means of tissue culture that there was direct transition from mesothelial cells to fibroblasts.

From this period onwards there has been much discussion as to the origin of these cells, all of which has arisen because embryologically the pleura arises from the mesoderm, and the question has been raised as to whether malignant tumours can develop from the mesoderm, the alternative view being that of Robertson (1924), that they are all secondary deposits in the pleura. Stout and Murray (1942) describe a case of mesothelioma of the pleura in which tissue cultures were made from the tumour, the medium being a mixture of rat and human plasma, human placental serum and extract of adult rat spleen. Subsequently, they altered the medium, replacing the mammalian plasmas

with chicken plasma. The tissue cultures are described, and the evidence for the origin of the various cells is discussed in detail. The authors' conclusions are inconclusive. They state that the origin of these cells can only be mesothelial because the experiment shows that these cells do not arise from the ectoderm or endoderm, but no direct evidence that the cells were mesothelial in origin was shown. Sano, Weiss and Gault (1950) describe a case of a patient with a mesothelioma, in which fragments of the tumour were inoculated into two types of tissue media: Tyrode's solution, 1 part: mouse embryo extract, 1 part: and autogenous human plasma, 1 part. In the other medium, chicken plasma was substituted for human plasma. Tumour cells grew rapidly, showing spindle cell formation close to the tumour and a flattened type of epithelial cell at the periphery. In other areas there was an alveolar arrangement of the cells. The tumour cells growing on the chicken plasma media showed various bizarre formations of the isolated cells in the periphery of the growth. They then point out that one of the features which determines the dominant type of cell is the plasma of the host, and state that cultures should be put up in autogenous plasma as well as standard chick plasma. The question of the ætiology of this condition still remains obscure. The point at issue is, are these apparently primary neoplasms of the pleura in fact primary, or do they arise from a pulmonary or other more distal neoplasm with secondary involvement of the pleura?

The autopsy findings in this kind of case are quite characteristic. There is neoplastic thickening up to half an inch and nodulation of the visceral pleura, with a collapsed and rounded lung closely applied to the mediastinum, although it may be adherent at the apex. The parietal pleura is similarly thickened and is removed with difficulty from the chest wall, as indeed muscle and even ribs may be infiltrated. This extra-pleural extension has been well marked in two of the cases that have been treated by radio-active gold, which, although it does seem to reduce the formation of fluid, does not affect the continued development of the growth. Dissection of the bronchi to the limit of the naked-eye vision shows no bronchial primary. The hilar nodes are involved, as is the diaphragm, and there may be peritoneal nodular deposits.

Cytology is not helpful, although the occurrence and persistence of sheets of mesothelial cells suggests that the condition is probably malignant.

The clinical picture of a pleural neoplasm may be produced by indicative tissue tumours in the chest wall, such as carcinomatous changes in intrathoracic neurofibromata. This was seen in a classical case of Von Recklinghausen's, but it has not been included in this series. The names given to this tumour are indicative of the confusion as to their origin; mesothelioma, endothelioma, sarcocarcinomata, etc. But it seems that few of the illustrated examples in the literature are incompatible with a spread from a carcinoma and very frequently indeed from an adeno-carcinoma. In those of our cases in which we have adequate material, a diagnosis of adeno-carcinoma has been made. However, the argument is whether mesothelioma exists. The pleura, pericardium and peritoneum all arise from the same primitive cavity, so that if the tumour exists the same type of growth should occur in all these sites. The reports of such a growth in the pericardium are suspect, as Reals, Russum and Walsh (1947) mention hilar node or even lung involvement, and invasion of the pericardium

is a common mode of spread of carcinoma of the bronchus, or a direct extension from a carcinoma of the thymus is also possible.

Joint cavities arising in the primitive mesenchyme are lined by cells derived from and only partially differentiated from the supporting connective tissue. Tumours arising in this site may therefore show the appearance of epithelialised clefts supported by a fibrous or sarcomatous stroma. This picture could be similar to that of the pleural growths arising from such primitive cells, and indeed pleural synovionota have been described, which has been supported by the demonstration of mucoproteins and hyaluronic acid in the accompanying effusion, but such substances are not specific to the synovial growths (Meyer and Chaffee, 1940).

It does seem remarkable that such tumours arise much more commonly in the pleura than the peritoneum, and in the cases followed there have been nineteen on the right side and five on the left. It is difficult to imagine that the potentialities of pleural cells are different on the two sides. If the pleural origin of these tumours is not acceptable, the pathological appearance must be explained by the present knowledge of the spread of malignant tumours.

In sections of lungs involved by a carcinoma there is no doubt that permeation in continuity along the perivascular and pleural lymphatics is exceedingly common. This is, of course, in addition to spread by local extension and lymphatic embolism. Occasionally such lymph vessel carcinomatosis is recognisable macroscopically by the reticular pattern of the thickened vessels. The mode of spread may be towards the periphery from a primary in the bronchus, or if the hilar nodes are involved there may be retrograde embolism and permeation so that the parietal pleura is affected. Permeated lymphatics may be marked in carcinoma of the breast and the extension may proceed to the hilum and thence over the lung. The growth at any time may spread by local extension to the surface, then there is effusion and a deposition of fibrin which organises and the fibrous tissue with its capillaries may itself be permeated by the growth.

Certainly this is one way in which the picture of mesothelioma is produced. In two cases the condition was discovered unexpectedly when the material from a decorticated lung was sectioned, the thickening of the pleura being assumed to be due to long-standing tuberculosis. The membrane removed as a peel showed carcinoma in the lung parenchyma and also in the thickened fibrous stroma. In two further cases which came to post-mortem there was lymphangitis carcinomatosis not only in the affected side but also contralaterally, although the complete picture of mesothelioma was not developed, and in two further cases there was carcinomatosis and effusion on both sides before death.

The behaviour of an adeno-carcinoma of the bronchus is different from the other types. Speaking generally, they may have a longer natural history, and they have a tendency to spread by lymphatics throughout the same and contralateral lung. The sex incidence is similar and does not show the great preponderance of men. They occur earlier in life, and, perhaps most important in this discussion, the cells of a bronchial adeno-carcinoma seem to be able to survive using pre-existing structures as a stroma, the striking example being the so-called alveolar cell carcinoma. So too can they proliferate on the

surface of the pleura. Some writers maintain that this implantation of detached cells on to serous surfaces is a more common cause of nodules than permeation. However, both mechanisms are likely.

In addition to those cases with primaries in the bronchus we have seen the condition of pleural neoplasm in association with primaries in the stomach, colon, rectum, prostate and breast. Pleural involvement may be delayed for up to thirteen years after the resection of such a primary. We have had two cases in women who had had a left mastectomy for carcinoma, one nine years and one thirteen years previously. They had had post-operative radiotherapy, yet in both cases the effusion and neoplasm was on the right side. The third woman, who had a right-sided effusion, had had a carcinoma of the left breast two years earlier and a cyst on the right side five years earlier. It is possible that the lymphatic permeation described by Handley (quoted by Willis, 1952), in carcinoma of the breast, has been able to take place only on the contralateral side because lymph channels had been obliterated by the radiotherapy. Similarly, it may be that previous tuberculosis affects the thoracic lymphatic drainage system, so that permeation may more easily occur. In one of these cases there had been a pleural effusion, almost certainly tuberculous, twenty-five years before the onset of the neoplastic one, and on the same side. Another had calcified lesions apparent in the X-ray and palpable at thoracotomy for a decortication. A further man, whose lung was decorticated, had healed tuberculous disease of the spine with deformity, and one of the women who had had a mastectomy and radiotherapy had an old tuberculous spine and later, when undergoing an adrenalectomy and oophorectomy, was also found to have a tuberculous kidney.

Pleural neoplasms arise by a particular form of spread, lymphatic permeation or implantation of a carcinoma. This is most commonly an adenocarcinoma. In this series the preponderance of right-sided lesions is striking but unexplained. The occurrence of true neoplasm of the pleura cannot really be denied, but as the lesion is produced from known primaries there is no need to postulate an origin in this site.

It is of interest to note that Yoffey and Courtice (1956) report in their book that there are differences in the absorption capacities of the visceral and parietal pleuras, suggesting that this may be due to the greater movement and absence of valves in the latter. It may be that these circumstances are also favourable for the spread of neoplasm toward the pleura, accounting for the observed greater extent of the disease on the parietal pleura.

In our view, all the cases reported as localised mesotheliomas by Heuer (1924), Sala (1930), Stout and Murray (1942), Stout and Himadi (1951), Claggett, McDonald and Schmidt (1952), Benoit and Ackerman (1953), Bogardus, Knudtson and Mills (1955), Katz (1955), and Blair, Reals and Wedin (1956), fall into one of the following groups: fibromas, fibro-sarcomas, lympho-sarcomas or sarcomas. Yesner and Hurwitz (1952) report a case of a localised tumour described as a mesothelioma which was essentially epithelial in nature. It is not clear that this was not in fact a secondary from an unidentified primary, or a developmental anomaly of the bronchial tree.

We would like to thank Dr. Gwen Hilton for her co-operation in supplying and giving the radio-active gold interpleurally.

Summary

Report of 24 cases of pleural neoplasm with pathological evidence either by post-mortem or biopsy. The clinical picture of this syndrome is reviewed and the treatment outlined, and the origin of these tumours discussed.

REFERENCES

ADLER, I. (1901): *J. med. Res.*, **6**, 175.
AYROLLES, P. (1884): *Bull. Soc. Anat. Paris*, p. 607.
BANERJEE, N. G., and DEY, N. C. (1956): *J. Indian med. Ass.*, **26**, 9, 352.
BANYAI, A. L., and GRILL, J. (1933): *Amer. Rev. Tuberc.*, **27**, 2, 193.
BARLAS, O. (1954): *Presse méd.*, **62**, 23, 493.
BARRETT, N. R., and ELKINGTON, J. ST.C. (1938): *Brit. J. Surg.*, **26**, 102, 314.
BASSOE, P. (1903): *Tran. Chicago path. Soc.*, **6**, 31.
BENDA, C. (1897): *Dtsch. med. Wschr.*, **21**, 324.
BENOIT, H. W., JR., and ACKERMAN, L. V. (1953): *J. thorac. Surg.*, **25**, 4, 346.
BIGGS, H. M. (1890): *Proc. N.Y. path. Soc.*, p. 119.
BIRNBAUM, G. L. (1938): *Qr. Bull. Sea View Hosp.*, **4**, 462.
BLAIR, A. E., REALS, W. J., and WEDIN, P. H. (1956): *J. Kansas med. Soc.*, **57**, 11, 65.
BODDAERT, J. (1956): *Acta clin. belg.*, **11**, 1, 82.
BOGARDUS, G. M., KNUDTSON, K. P., and MILLS, W. H. (1955): *Amer. Rev. Tuberc.*, **71**, 2280.
BUTLER, G. R. (1898): *N. York med. J.*, **67**, 247.
CHAPTAL, J., CAMPO, A., JEAN, R., and CAMPO, C. (1956): *Poumon*, **12**, 4, 341.
CHARCELAY, M. (1836): *Bull. Soc. Anat. Paris*, p. 58.
CLAGETT, O. T., MCDONALD, J. R., and SCHMIDT, H. W. (1952): *J. thorac. Surg.*, **24**, 3.
CLARKSON, F. A. (1914): *Canad. med. Ass. J.*, **4**, 192.
COLLIER, W. (1885): *Lancet*, **2**, 945.
CRIEP, L. H. (1927): *Med. Bull. Veterans' Adm.*, **3**, 919.
DELAFIELD, F. (1902): *Med. Rec. (N.Y.)*, **62**, 761.
DELATOUR, H. B. (1903): *Brooklyn med. J.*, **17**, 179.
DELATOUR, H. B. (1908): *Med. Rec. (N.Y.)*, **74**, 867.
DOUB, H. P., and JONES, H. C. (1942): *Radiology*, **39**, 1, 27.
DU BRAY, E. S., and ROSSON, F. B. (1920): *Arch. intern. Med.*, **26**, 1, 715.
EASTWOOD, E. H., and MARTIN, J. P. (1921): *Lancet*, **22**, 172.
FOURESTIER, M., and DURET, M. (1943): *Presse méd.*, **51**, 467.
FREEMAN, W. (1921): *Int. Clin.*, **4**, 31st series, 159.
GAARDE, F. W., and SUTHERLAND, C. H. (1925): *Radiology*, **5**, 526.
GERUNDO, M. (1941): *J. Kansas med. Soc.*, **42**, 18.
GESCHICKTER, C. F. (1936): *Amer. J. Cancer*, **26**, 2, 378.
HACHE, M. (1834): *Bull. Soc. Anat. Paris*, p. 190.
HARVEY, W. F., DAWSON, E. K., and INNES, J. R. M. (1940): *Edinb. med. J.*, **47**, 513.
HASHIBA, G. K., COWAN, A. B., and NIXON, C. E. (1932): *Calif. west. Med.*, **37**, 385.
HEISE, F. H., and TRUDEAU, F. B. (1927): *Amer. Rev. Tuberc.*, **16**, 92.
HEUER, G. J. (1924): *Ann. Surg.*, **79**, 670.
HOCHBERG, LEW A. (1939): *Radiology*, **32**, 6, 713.
HOCHBERG, LEW A. (1951): *Amer. Rev. Tuberc.*, **63**, 2, 150.
HOCHBERG, LEW A., EPSTEIN, I. G., and PERNIKOFF, M. (1947): *Dis. Chest*, **13**, 6, 621.
KATZ, SOL. (1955): *G.P. (Kansas)*, **12**, 4, 119.
KEILTY, R. A. (1917): *Amer. J. med. Sci.*, **153**, 6, 888.
KLEMPERER, P., and RABIN, C. N. (1931): *Arch. Path.*, **11**, 3, 385.
KLEMPERER, P., and TEDESCHI, C. (1942): *J. Mt Sinai Hosp.*, **8**, 710.
LAENNEC, R. T. H. (1819): "De l'Auscultation Médicale," vol. II, p. 368. (Paris: J. A. Brosson and J. S. Chaudé.)
LESIEUR, SAVY and MAZEL (1913): *Arch. med. exp.*, **25**, 392.
LEWIS, D. D. (1905): *Trans. Chicago path. Soc.*, **6**, 256.
LEWIS, W. H. (1923): *J. exp. Med.*, **38**, 257.
LEY, R. A. (1929): *Brux.-méd.*, **10**, 57.
LIEUTAUD, JOSEPH (1767): "Nelson New Loose-Leaf Surg.," vol. 4, 546. (London: Thomas Nelson.)
LINDQVIST, S., and BERGSTRAND, H. (1932): *Acta. chir. scand.*, **72**, 115.
LORD, F. T. (1925): "Diseases of the Bronchi, Lungs and Pleura." 550. (Philadelphia: Lea and Fiebiger.)
MCDONALD, S., JR. (1936): *J. Path. Bact.*, **43**, 137.

McDONNELL, P. J., and MAXWELL, E. S. (1920): *J. Amer. med. Ass.*, **74**, 168.
MACMAHON, H. E., and MALLORY, G. K. (1928): *Amer. J. Path.*, **4**, 387.
MAXIMOW, A. (1927): *Arch. exp. Zellforsch.*, **4**, 1.
MESLAY and LORRAINE (1903): *Bull. Soc. Anat. Paris*, p. 88.
MEYER, K., and CHAFFEE, E. (1940): *J. biol. Chem.*, **133**, 32.
MILLER, J., and WYNN, W. H. (1908): *J. Path. Bact.*, **12**, 267.
MONTAGUE, E. A. (1932): *Med. Bull. Veterans' Adm.*, **9**, 92.
MUSSET, M. (1850): *Bull. Soc. Anat. Paris*, p. 376.
PITT, G. N. (1887): *Tr. path. Soc. Lond.*, **39**, 56.
POSTOLOFF, A. V. (1944): *Arch. Path. (Chicago)*, **37**, 4, 286.
PULFORD, D. SCHUYLER, Jr. (1925): *Ann. Surg.*, **82**, 5, 710.
RAVENNA, E. (1905): *Arch. Med. exp.*, **17**, 325.
REALS, W. J., RUSSUM, C., and WALSH, E. M. (1947): *Arch. Path. (Chicago)*, **44**, 380.
ROBERTSON, H. E. (1924): *J. Cancer Res.*, **8**, 317.
SACCONE, A., and Coblenz, A. (1943): *Amer. J. clin. Path.*, **13**, 186.
SALA, A. M. (1930): *Arch. Path.*, **9**, 950.
SANO, M. E., WEISS, E., and GAULT, E. S. (1950): *J. thorac. Surg.*, **19**, 783.
SAUNDBY, R. (1889): *Bgham. med. Rev.*, **25**, 34.
SPRUNT, T. P. (1911): *Bull. Johns Hopk. Hosp.*, **22**, 289.
STOUT, A. P., and MURRAY, M. R. (1942): *Arch. Path.*, **34**, 951.
STOUT, A. P., and HIMADI, G. M. (1951): *Ann. Surg.*, **133**, 50.
TOBIASSEN, G. (1955): *Acta. path. microbiol. scand.*, Supplement 105, p. 198.
VITKUS, J. T. (1937): *Ohio St. med. J.*, **33**, 1007.
WESSLER, H., and JACHES, L. (1923): "Clinical Roentgenology of Diseases of the Chest." Troy, N.Y.: The Southwood Co.
WILLIS, R. A. (1952): "The Spread of Tumours in the Human Body," p. 5. (London: Butterworth.)
YESNER, R., and HURWITZ, A. (1952): *J. Thorac. Surg.*, **26**, 325.
YOFFEY, J. M., and COURTICE, F. C. (1956): "Lymphatics, Lymph and Lymphoid Tissue," 2nd ed., p. 193. (London: Edward Arnold.)
YOUNG, J. S. (1928): *J. Path. Bact.*, **31**, 265.
ZOHLEN, J. P. (1934): *Wisconsin med. J.*, **33**, 202.

SARCOMA OF THE LUNG

A REPORT OF THREE CASES

By P. A. Feldman

From the London Chest Hospital

Primary sarcoma of the lung is a rare condition and the number of cases reported has fallen considerably since the classic paper of Barnard (1926) differentiating oat-celled carcinoma from sarcoma.

Peters (1924), reporting 13 cases of primary pulmonary sarcoma out of 6,208 admissions over four years, concluded that it was a relatively common condition. Some were chondro-sarcoma or other forms of differentiated sarcoma. Ellis (1939), reporting one case, said that of 7,272 autopsies there were 38 examples of primary pulmonary malignancy (an incidence of 0·5 per cent.). Only one of these was a sarcoma (0·01 per cent.). He also said that most previously reported sarcomata had, in fact, been oat-celled carcinomata. He emphasised that for a conclusive diagnosis the tumour cells must lie on the endothelium of the blood vessels and there must be an intercellular reticulum.

Noehren (1954) stated that up to 1936 one case of pulmonary sarcoma in 8,000 autopsies had been reported from the Massachusetts General Hospital, and that only 3 had since been reported from there. He reported one case and traced 34 reports from 1912 onwards.

Iverson (1954) reported 3 cases from the American Armed Forces Institute of Pathology. Two of these were incidental findings on routine chest X-rays; one had complained of some tightness of the chest for which he had been investigated. All three had resections performed and macroscopically there were firm white masses which were partly encapsulated. Microscopically they were spindle-celled sarcomata. Two were followed for three years without metastases appearing, but the third died within a year with metastases at autopsy. Iverson states that the differentiation from other rare pulmonary neoplasms may be difficult and mentions especially endobronchial sarcoma, which may be well differentiated and may be mistaken for secondary inflammation or even reticulo-endothelial cells on section. Other tumours are myxo-lipo-sarcoma and rhabdo-myo-sarcoma. He concludes that pulmonary sarcoma is of relatively long duration with metastases in one-third of the cases and that other forms of primary pulmonary sarcoma are extremely rare.

Most of the reported cases have had a history of dyspnœa, cough with or without blood-stained sputum, fever, pain in the chest and loss of weight. Chest X-ray usually showed a pleural effusion and sometimes also a discrete lesion. In most cases a chest aspiration yielded blood-stained fluid. Resection was possible in most cases although sometimes there was involvement of the pulmonary veins and left auricle. Autopsy showed spread to the liver and brain. In over 50 per cent. death followed within six months of diagnosis.

Since 1945, 10,237 patients have been admitted to the London Chest

(*Received for publication April* 30, 1957.)

Hospital, among which there have been 3 cases of undifferentiated sarcoma of the lung, an incidence of 0·03 per cent., and these 3 cases are reported here.

CASE 1. P.T., a girl of 11, was admitted under Mr. Vernon C. Thompson in October 1953, having coughed up a little blood. There was no clinical abnormality, but chest X-ray showed an opacity in the left lower zone. She had no sputum and her Mantoux was negative to 1 in 100. Tomography showed a solid lesion in the left lower lobe. Left thoracotomy was performed by Mr. Thompson and a soft mass about 2 inches in diameter was found in the anterior basal segment of the lower lobe. Segmentectomy was performed, during which the lesion was opened and a thick yellow core was extruded. The report on the specimen, by Dr. K. F. W. Hinson, described, "A lower segmentectomy specimen from which a yellow mass has extruded, leaving a ragged cavity at the apex. The mass is extremely cellular with smaller areas of degeneration and hæmorrhage. The cells are pleomorphic and individual giant forms occur. Mitoses are not frequent, but the tumour is probably a sarcoma. In the walls of the cavity there is some local infiltration but distant metastases have not occurred. The tumour may have been intra-bronchial, as in an adjacent small branch there is a polypoid portion remaining." (Fig. 1.) She was referred for deep X-ray therapy, but this was not considered justifiable at the time. She was seen at the follow-up clinic, and in December 1956 the chest was radiologically clear.

CASE 2. B.R., a girl of 13, was admitted under Dr. N. S. Plummer in September 1949 with a history of a dull ache in the back, followed by pains in the left side, the previous July. She was admitted elsewhere where X-ray showed a shadow in the left chest, believed to be fluid, although aspirations revealed none. She was transferred to the London Chest Hospital where it was found that the trachea was displaced to the right. The left side moved less than the right and percussion was impaired over the left middle and lower zones. An artificial pneumothorax was attempted but no space was found. She was referred to Mr. V. C. Thompson, whose opinion was that this was a malignant tumour involving the chest wall. At bronchoscopy the left main bronchus was found to be grossly narrowed at the level of the carina. Bronchograms showed a normal bronchial tree and an extra-pulmonary tumour. Punch biopsy showed a cellular tumour on which Dr. Hinson reported: "The cells are vacuolated and in some the nucleus is displaced in a manner reminiscent of fat cells. The nuclei are irregular and there are a fair number of mitotic figures. The scanty blood vessels are primitive. I think this is a malignant tumour, and although the nature of the vacuolation cannot now be determined it is possibly a liposarcoma." This was not confirmed by further biopsy.

She was transferred to Charing Cross Hospital for deep X-ray therapy, which was given with good results. It was then considered that surgery was now a reasonable procedure, and this was undertaken in March 1950, when a left lower lobectomy was performed. The tumour was attached to the seventh rib and the sixth and seventh intercostal muscles. The involved portions of rib and muscle were removed. Dr. Hinson's report on these specimens is: "A left lower lobe showing in its postero-lateral aspect a tumour with a portion of overlying rib. The periosteum of the inner aspect of the rib is thickened and the rib itself is eroded. There are two large areas of necrosis within the tumour. Microscopically the outer portion of the tumour is formed of firm fibrous tissue with islands of highly cellular undifferentiated sarcomatous tissue. (Fig. 2.)

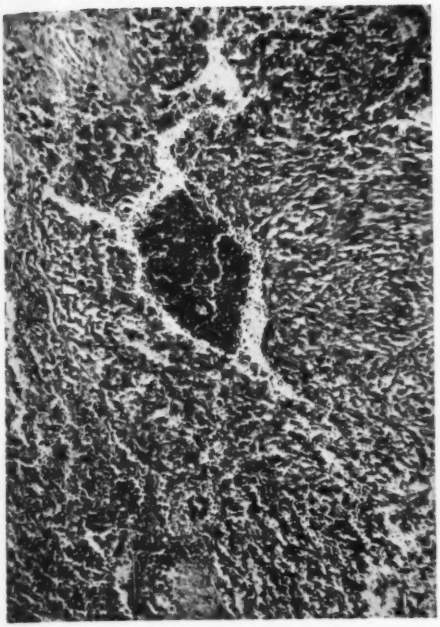


FIG. 1

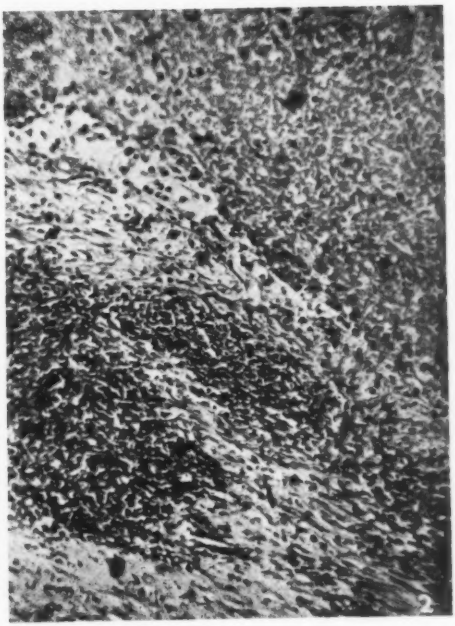


FIG. 2

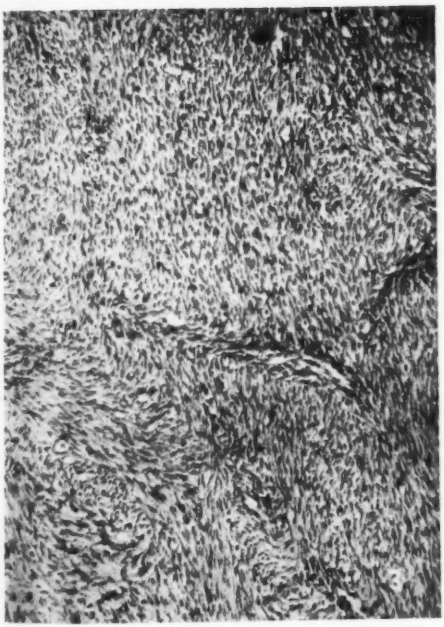


FIG. 3

FIG. 1.—Invasion of lung by sarcoma. H & B × 90.

FIG. 2.—Islands of deeply staining sarcoma cells amidst post radiotherapeutic necrosis. H & E × 90.

FIG. 3.—Small separate fibroma from first thoracotomy. H & E × 90.

To face p. 332

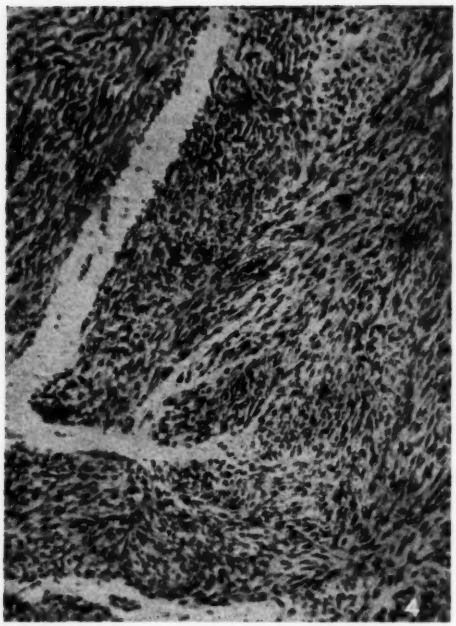


FIG. 4.—Undifferentiated sarcoma from pleuropneumonectomy. H & E × 90.

FIG. 5.—Recurrence in thoracotomy scar. H & B × 90.

The larger cellular areas are almost completely necrotic with only ghosts of cells visible. The more mature portions of the tumour show no nerve cells or fibrils. The tissue removed separately shows muscle, fat and fibrous tissue. In the latter there are a few areas of necrosis in which the ghosts of tumour cells are present, showing that extension must have occurred."

She was referred for further radiotherapy, but died five months after operation. At post-mortem, a mass of neoplasm was found in the dome of the left pleura, with spread to the mediastinum; also metastases in lymph nodes, liver, ovary and skull.

Case 3. H.B., a man of 35, first attended the London Chest Hospital at the end of October 1955, complaining of a cold of one week's duration, and about 1 oz. of blood-stained sputum daily over the previous five days. He had been off colour and tired for three months. There was no history of dyspnœa or night sweats, no pain in the chest, and he smoked thirty cigarettes daily. X-ray showed a cyst containing fluid and air in the right mid-zone. A diagnosis of infected cyst was made. He was admitted 7.11.55, when examination revealed the liver to be slightly enlarged. Screening showed the diaphragm moving well; the fluid in the cyst was moving freely. 21.11.55: right thoracotomy by Mr. J. R. Belcher. There were dense vascular adhesions over the whole of the right lung, especially over the middle lobe and the anterior basal segment of the lower lobe. There was a large " emphysematous cyst " filled with stale blood lying between the middle and lower lobes. The lateral wall of the cyst was excised and the chest closed with drainage. He was discharged 2.12.55. The report by Dr. Hinson stated: " The specimen is an emphysematous cyst with an unusual amount of clot in it. Within the clot are the ghosts of alveolar walls. Also within the specimen is a small separate fibroma." (Fig. 3.)

The patient was seen at intervals in the Follow-up Department until 21.8.56, when X-ray showed a pleural effusion in the region of the right lower lobe. He was admitted 27.8.56 and 4 oz. of slightly blood-stained fluid were aspirated. This was sterile after 24 hours' incubation. The sputum did not show any neoplastic cells. He was discharged two days later.

He was readmitted on 7.9.56, as he had coughed up a fair amount of fresh blood. On examination there was impaired movement and percussion note in the right lower chest, with absent breath sounds. X-ray showed an opacity, probably due to a collection of pleural fluid. Methylene blue was injected into the pleura but was not coughed up subsequently. Chest aspiration showed blood-stained fluid plus some mucoid material. This was again sterile on culture. A diagnosis of possible hæmothorax or underlying carcinoma was made.

15.9.56. Right pleuro-pneumonectomy by Mr. D. A. Watson. Preliminary bronchoscopy was normal. A postero-lateral thoracotomy showed friable growth and a frozen section was reported as malignant. A pleuro-pneumonectomy was performed. The sixth rib was removed as this was infiltrated. Inferiorly the diaphragm was also involved and part had to be removed. All the nodes appeared to be normal. He was discharged 14.10.56. Dr. Hinson's report stated: " A right pleuro-pneumonectomy specimen with an overlying rib. The anterior and basal part of the lung is replaced by hæmorrhagic necrotic growth which also infiltrates the rib. Microscopically the tumour is an undifferentiated sarcoma of undetermined origin." (Fig. 4.)

Rescrutiny of the original specimen and sections shows no reason for changing the original diagnosis from simple fibroma. The fibroma appears to have behaved as many fibromata do following removal, that is, recurrence with an alteration of type towards malignancy.

He has recently been readmitted with recurrence in the scar and at operation extensive intra-thoracic spread was found and excised. (Fig. 5.)

Discussion

Previous authors have come to the conclusion that sarcoma of the lung is a condition of relatively long duration in one-third of the cases. Consequently an attempt at radical surgery is worth while.

Of the cases reported here, one has been followed for nearly four years and is completely symptom-free. One has had a recurrence in the scar and within the chest, but has survived ten months since the change from fibroma to sarcoma was detected. The third case died five months after radiotherapy plus surgery.

Summary

Three cases of primary sarcoma of the lung are described. The prognosis confirms previous accounts. The literature is reviewed.

My thanks are due to Mr. Vernon C. Thompson for case 1, to Dr. N. S. Plummer and Mr. Thompson for case 2, and to Mr. J. R. Belcher for case 3, and for their permission to report these cases. My thanks are also due to Mr. Belcher for his encouragement and assistance in the preparation of this paper, and to Dr. K. F. W. Hinson for the pathological reports and photographs.

REFERENCES

Barnard, G. W. (1926): *Path. and Bact.*, **29**, 241.
Ellis, R. S. (1939): *Kansas med. Soc.*, **40**, 23.
Iverson, L. (1954): *Thor. Surg.*, **27**, 130.
Noehren, T. H., and McKee, F. W. (1954): *Dis. Chest*, **25**, 663.
Peters, C. A. (1924): *Med. Clin. N. Amer.*, **7**, 1823.

SPONTANEOUS CLOSURE OF LARGE PULMONARY BULLÆ

A REPORT ON THREE CASES

By A. C. Douglas and I. W. B. Grant

From the Respiratory Diseases Unit, Northern General Hospital, Edinburgh, and Department of Tuberculosis and Diseases of the Respiratory System, University of Edinburgh

Whatever the ætiological factors concerned in the production of pulmonary bullæ, the treatment adopted in any particular case depends largely on whether the bulla or system of bullous lesions is regarded as an isolated abnormality in otherwise healthy lungs or as part of a diffuse pulmonary disorder. Such a distinction may be difficult to make. A patient presenting with an apparently single bulla may, for example, later prove to have multiple bullous lesions elsewhere in the lungs. This may be shown, or at least suspected, in tomograms or bronchograms, but in some cases the full extent of the lesions does not become evident until thoracotomy is undertaken. Moreover, bullæ, whether single or multiple, are often associated with generalised pulmonary emphysema, and in such cases it may be extremely difficult to assess the importance of the bullæ *per se* in the production of the patient's exertional dyspnœa. There can, however, be little disagreement with the view that large bullæ, by compressing adjacent lung tissue, are always responsible for some loss of ventilatory function, whether or not generalised emphysema coexists.

In an effort to correct this situation various procedures, all of them surgical, have been devised with the object either of closing the bullæ or removing them. Thoracoplasty for closure of bullæ has proved unsatisfactory. Monaldi drainage after preliminary pleurodesis (Head *et al.*, 1949), although seemingly a more rational procedure, has given equally disappointing results. Resection of the pulmonary unit containing the bulla represented a considerable advance on the older methods of treatment, and the results were fairly satisfactory provided that a minimum of functioning lung tissue was removed (Massie *et al.*, 1954). Recently, good results have been reported by Stringer and Burnett (1956), who obliterated the bullæ by removing the pleural roof, closing the bronchial connections and finally approximating the walls by continuous suture. This method has the advantage over formal resection that it does not involve removal of any functioning lung tissue.

Despite these advances the current treatment of bullæ is still not wholly satisfactory. In some cases other bullæ develop or enlarge after operation, while in others any major surgical intervention is contra-indicated or rendered extremely hazardous by the bilateral distribution of the lesions or by inadequate pulmonary function consequent upon generalised emphysema. In such cases, and no doubt in others too, it would clearly be advantageous if a form of treat-

(*Received for publication June* 27, 1957.)

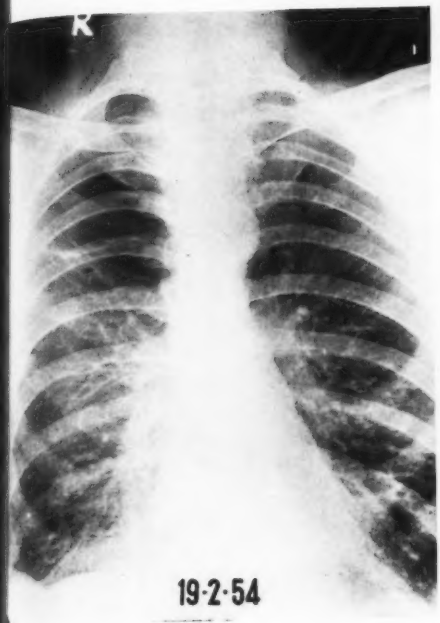
ment not involving major surgery were available. Three cases recently seen in this Unit may give a pointer to a non-surgical method of closing large bullæ.

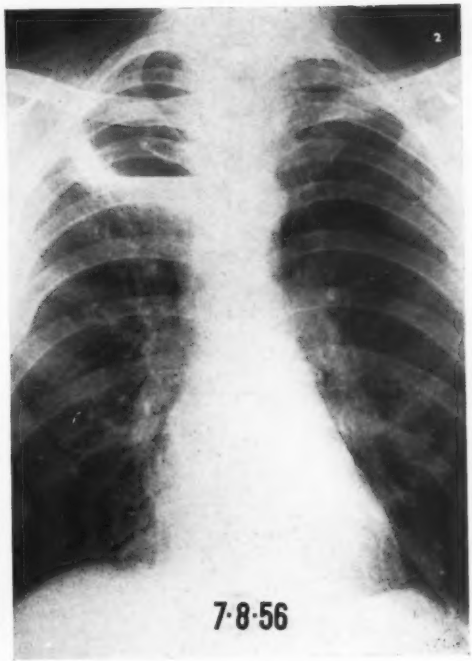
Case Reports

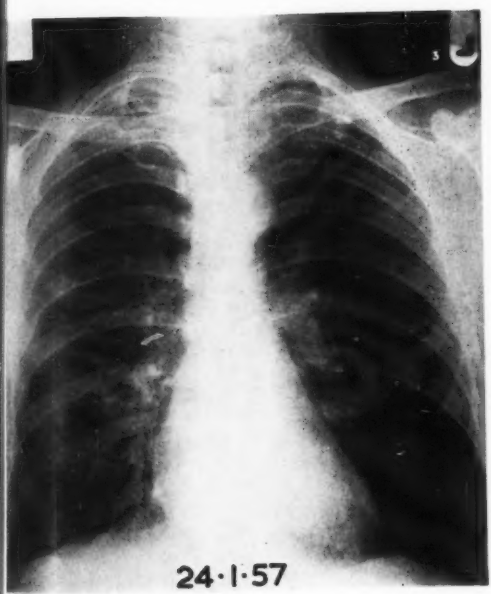
Case 1. Male, aged 59. This patient was found at a Mass Radiography Survey in 1954 to have a large apical bulla, measuring 9×8 cm., in the right lung (Fig. 1). He gave a history of chronic bronchitis for several years but with only mild exertional dyspnœa. Further chest radiographs over the next two years showed no change in the size of the bulla. In July 1956 he developed an acute respiratory infection and the sputum became purulent. He was admitted to hospital, where a chest radiograph showed inflammatory changes in the lung adjacent to the bulla and a small collection of fluid within it (Fig. 2). Postural drainage did not reduce the amount of fluid. Bronchoscopy was negative. The sputum became mucoid with antibiotics and within a week the inflammatory changes around the bulla had largely resolved. On discharge from hospital after four weeks the bulla was smaller, measuring 6×6 cm., although the amount of fluid remained unchanged. The patient then returned to work. There was a progressive reduction in the size of the bulla and, five months after the initial incident, it had closed completely (Fig. 3). A small amount of fluid persisted within the bulla until it closed.

Case 2. Male, aged 57. This patient, who gave a history of chronic bronchitis for many years, first came under observation in 1954 when a chest radiograph showed multiple bullæ throughout both lungs with a large bulla measuring 15×12 cm. in the right upper lobe (Fig. 4). In September 1956, following an upper respiratory infection, he developed right pleuritic pain and was admitted to hospital. He was afebrile, the sputum was mucoid and there was no increase in his usual slight exertional dyspnœa. A chest radiograph showed a fluid level in the large bulla (Fig. 5). Postural coughing supplemented by chest percussion failed to reduce the amount of fluid and a course of penicillin combined with streptomycin was similarly ineffective. Bronchoscopy was negative. The patient was discharged from hospital after eleven days and returned to work at once. The bulla has since become progressively smaller. This was due, in the first two months, to the gradual and eventually complete absorption of air and subsequently to a decrease in the fluid content. When the patient was last examined eight months after discharge from hospital the bulla presented as a homogeneous opacity 8·5×3 cm. (Fig. 6). The shrinkage of the bulla was accompanied by marked displacement of the trachea to the same side and a slight increase in size in several of the smaller bullæ in the right upper lobe.

Case 3. Male, aged 45. This patient, who gave no previous history of respiratory disease, developed an upper respiratory infection in October 1956, and one week later had right pleuritic pain with cough and purulent sputum. A postero-anterior chest radiograph at this time demonstrated a fluid level in the right upper zone and an apical view showed a fairly large right apical bulla measuring 6×5·5 cm. with a small amount of fluid within it and minor inflammatory changes in the surrounding lung. There were also small bullæ at the left apex. The patient was admitted to hospital and treated with penicillin. The sputum rapidly became mucoid and the inflammatory changes around the bulla cleared although the size of the bulla and the amount of fluid within







Top left:

FIG. 1.—Posterior—anterior chest radiograph (Case 1) showing large bulla in right upper lobe.

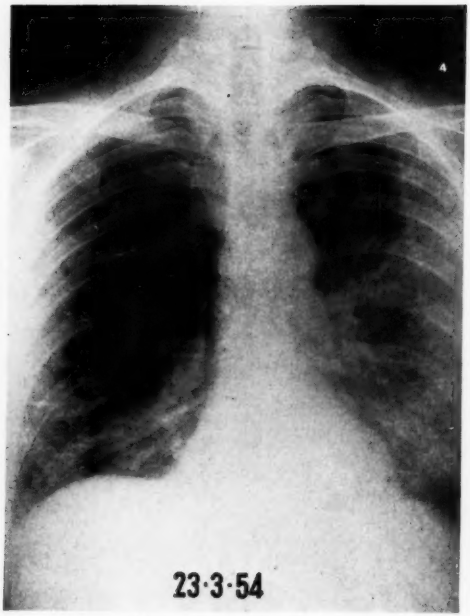
Top right:

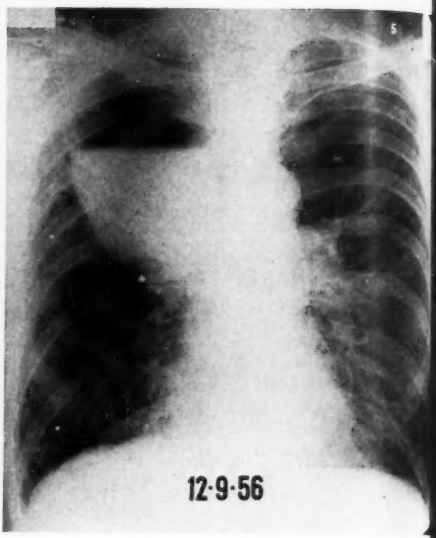
FIG. 2.—Posterior—anterior chest radiograph (Case 1) showing fluid level in bulla.

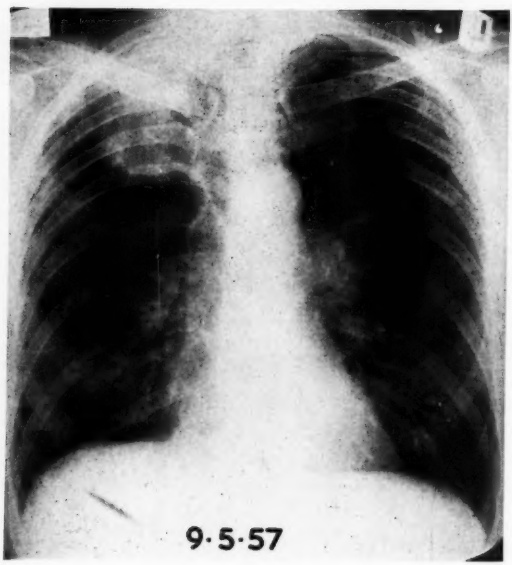
Bottom:

FIG. 3.—Posterior—anterior chest radiograph (Case 1) showing closure of bulla.

To face p. 336







Top left:

FIG. 4.—Posterior—anterior chest radiograph (Case 2) showing large bulla in right upper lobe.

Top right:

FIG. 5.—Posterior—anterior chest radiograph (Case 2) showing fluid level in bulla.

Bottom:

FIG. 6.—Posterior—anterior chest radiograph (Case 2) showing homogenous opacity at site of bulla.

it remained unchanged. Bronchoscopy was not carried out. The patient was discharged after two weeks but penicillin was continued at home for a further fortnight. Subsequent radiographs showed a gradual reduction in the size of the bulla as a result of the absorption of air. The amount of fluid remained unchanged until closure of the bulla, confirmed by tomography, was observed after four months.

In none of the patients was exertional dyspnœa incapacitating and closure of the bulla did not, therefore, result in any dramatic alteration in functional status. Serial estimations of lung volume, mixing efficiency, maximum breathing capacity and forced expiratory volume (2 sec.) were made in one patient (Case 2). The results obtained (*a*) on admission to hospital and (*b*) at the time of the last radiological examination eight months later are shown in the table together with the predicted normal values.

VENTILATORY FUNCTION TESTS (CASE 2)

	Actual		
	(*a*)	(*b*)	*Predicted*
Total lung capacity	5,840 ml.	5,850 ml.	5,800 ml.
Vital capacity (V.C.)	3,750 ml.	3,800 ml.	3,800 ml.
Residual volume (R.V.)	2,090 ml.	2,050 ml.	2,000 ml.
Intrapulmonary mixing efficiency	54%	60%	> 60%
Forced expiratory volume (2 sec.)	3,075 ml.	3,200 ml.	> 3,500 ml.
Maximum breathing capacity (M.B.C.)	68 L./min.	80 L./min.	102 L./min.

The fact that the mixing efficiency was normal (Siebens *et al.*, 1957) and there was no increase in R.V. suggests that, when the first series of tests was carried out, the bulla was not in communication with the bronchial tree and this was also considered likely on clinical grounds in view of the fluid level in the bulla and the subsequent course of events. It is surprising that the figures for V.C. and R.V. should have remained unaltered after shrinkage of the bulla, but the rise in M.B.C. suggests that, whatever the physiological mechanism, ventilatory function was improved. The increase in M.B.C. from 68 to 80 litres per minute was, however, too small to be of clinical importance at this level of ventilatory function.

Discussion

Spontaneous closure of a large pulmonary bulla is an uncommon event. Its occurrence in the cases reported here followed the appearance of fluid in the bulla, this being associated with a mild infective exacerbation of chronic bronchitis in all three cases. If a similar course of events could be reproduced therapeutically the reduction in size, or closure, of a large bulla might allow compressed lung tissue to re-expand and thus bring about some improvement in respiratory function.

The spontaneous closure of the bullæ in our three cases was presumably due to the obliteration of the bronchial stomata by inflammatory exudate and the subsequent absorption of the contents of the bulla. Although the operative factor in these three cases was probably a bacterial infection, it is conceivable that the deliberate induction of a controlled inflammatory process,

possibly by a chemical agent such as is used in pleurodesis, would achieve a similar result. The procedure would not be devoid of risk and a previous attempt to obliterate the pleural space would probably be advisable to avoid the development of tension pneumothorax following the insertion of a needle into the bulla. This, however, need not have serious consequences in a well-equipped Chest Unit.

Summary

Three cases of spontaneous closure of a large pulmonary bulla are described. In each case closure followed the appearance of fluid in the bulla. A suggestion is made for the treatment of large bullæ by a method not requiring thoracotomy.

Our thanks are due to Mrs. Mary C. Beaton for carrying out the respiratory function tests, to Professor John Crofton for permission to include one of his patients (case 3) in the report and for helpful criticism, and to Miss Winifred A. M. Tait for secretarial assistance.

REFERENCES

HEAD, J. R., and AVERY, E. E. (1949): *J. thorac. Surg.*, **18**, 761.
MASSIE, J. R., jun., and WELCHONS, G. A. (1954): *Ann. Surg.*, **139**, 624.
SIEBENS, A. A., GRANT, A. R., KENT, D. C., KLOPSTOCK, R., and CINCOTTI, J. J. (1957): *J. thorac. Surg.*, **33**, 761.
STRINGER, C. J., and BURNETT, C. A. (1956): *Amer. Rev. Tuberc.*, **74**, 856.

AN EXPLOSIVE OUTBREAK OF PRIMARY ATYPICAL PNEUMONIA

By G. H. Renton

From Runwell Hospital, Essex

This paper describes, in an institution for female mental defectives, an explosive outbreak of an infectious type of pneumonia, presumably due to an unidentified virus.

The term "primary atypical pneumonia" is used, although it is not altogether satisfactory (Reimann, 1945 and 1947; Scadding, 1948).

Epidemiology and Presentation

The outbreak was confined to one building, accommodating 130 imbeciles of whom 26 became acutely ill with a respiratory illness. Three nurses had an acute respiratory illness, one ten days before the outbreak and two during the first days of the outbreak. The history taken in retrospect from these nurses, who were non-resident, was suggestive of a similar illness to that herein described.

One of the nurses, who became ill on the third day of the epidemic, kept budgerigars, which she reported to be well at the time and which one year later remained well.

Table 1.—The Day-to-day Case Incidence

Day of outbreak	*No. of cases*	*Day of outbreak*	*No. of cases*	*Day of outbreak*	*No. of cases*	*Day of outbreak*	*No. of cases*
1	1	5	1	9	1	13	1
2	0	6	2	10	4	14	1
3	0	7	0	11	2	15	3
4	0	8	2	12	6	16	2

The cases were distributed as shown in Table 1.

The onset was abrupt and the patient either refused a meal or was noted to be flushed. It became possible to single out cases by the presence of a characteristic dusky flush of the face and bright watery eyes. The temperature was raised to 101°-103° F., the pulse rate to 120-130 per min. and the respiratory rate to 28-36 per min. A dry cough was invariable and a serous nasal discharge common. On the second or third day herpes labialis developed. There was slight faucial injection without cervical gland enlargement. No other abnormal physical signs were found, except in the respiratory system, examination of which revealed tachypnœa, occasional dyspnœa, slight impairment of percussion note, localised high-pitched inspiratory rhonchi and/or fine crepitations at the height of inspiration. The temperature was intermittent and settled by

(*Received for publication June* 14, 1957.)

lysis over a period of four to five days. The cough became more productive and the earlier signs were replaced by fine to medium inspiratory and expiratory crepitations. The patients appeared comfortable by the third day and the physical signs had disappeared within seven to fourteen days.

Clinical Features

Five patients only were able to give an account of their symptoms. All five complained of frontal headache, one of retrosternal pain and one of pain in the left axilla.

The temperature, highest on the first or second day, subsequently fell to normal in the great majority of cases by the ninth day. Nineteen patients showed a dusky flush and bright suffused eyes at their first examination, which was so characteristic that it was helpful in the early diagnosis. Twenty-two patients had a serous nasal discharge, frequently unilateral, which later became sero-purulent. All patients had a cough which, dry at first, later became more productive. The sputum (from eleven patients) was initially mucoid and tenacious and later muco-purulent. Frank blood streaking was present in four cases, whilst the sputum of the remaining seven cases had a faint pinkish tinge. Herpes labialis developed in twelve patients and one patient had an herpetiform keratitis. Twenty patients developed clinical signs of focal pulmonary involvement, usually with fine crepitations, reduced breath sounds and rhonchi. Fourteen patients also showed dullness to percussion in the affected areas and three bronchial breathing over a typically lobar distribution. Of the remaining six patients who had no signs other than cough, five had no X-ray evidence of a lesion, but one had a right middle lobe opacity.

Investigations

Of twenty-one white cell counts performed on the first or second day of the disease, fifteen showed a polymorphonuclear count greater than 8,000 per c.mm., and of these six were greater than 16,000, the highest being 30,000. Five counts between the third and ninth days of the illness were normal. No abnormal cell forms were seen. The sputa from eleven patients in all cases produced a mixed growth of the normal respiratory tract flora. A trace of albumin was present in sixteen urines, granular casts in two, tubular casts in one and a moderate number of W.B.C. and R.B.C. in six. Three patients had bile in the urine; the patient with the most strongly positive test had no liver enlargement, was not jaundiced and had normal liver function tests.

" Cold agglutinins " were sought in all cases, three during the acute phase of the illness, eight in both the acute and convalescent phases, and fifteen in the convalescent phase only. All the " acute " sera were negative. Of the " convalescent " sera, sixteen were negative and seven were positive with titres ranging from $\frac{1}{2}$ to $\frac{1}{16}$.

" Complement fixation " and " agglutinin " tests were carried out by the Central Public Health Laboratory, Colindale, on six patients, both in the acute and convalescent phases of the illness. Tests for influenza A, B and C, Q fever, psittacosis and lymphogranuloma venereum and streptococcus MG all gave negative results.

Radiology

Four patients' films were unsatisfactory, due to lack of co-operation. Of twenty-one patients, fifteen had abnormal X-rays. These consisted of mottled opacities in four and dense homogeneous opacities in nine. Decreased translucency of one lung field was seen in one and the remaining X-ray was suggestive of left lower lobar collapse. The shadowing was more commonly in the lower lobes, and appeared in both lower lobes in one case. In two cases the opacity involved a whole lobe.

Of six cases with normal X-rays, three had no clinical signs in the chest, other than cough, and three had areas of fine crepitations at the bases.

Course and Treatment

The illness was mild in five patients and moderately severe in nineteen. Two patients became seriously ill, developing signs of shock, and one died on the eleventh day of illness.

The moderately severe cases were treated with soluble penicillin injections or chloromycetin or aureomycin in standard dosages. The mild cases received no antibiotics.

The few patients treated and the absence of controls, other than those mildly ill, prohibit the expression of any opinion as to the efficacy of the various antibiotics used. Dramatic falls of temperature occurred in all groups, both treated and untreated.

Complications and Associated Conditions

Six patients developed otitis media, of whom five had a history of chronic otitis media. Two patients developed pleural effusions, one requiring thoracocentesis for severe dyspnœa. One pint of straw-coloured clear fluid was aspirated, which on microscopic examination revealed 4,760 R.B.C. per c.mm. and 1,870 W.B.C. per c.mm., the majority lymphocytes. No organisms were cultured.

Illustrative Case Histories

Case 1. A.T., aged 52. On examination her temperature was 101° F., pulse rate 112 per min. and respiratory rate 28 per min. She had a dry cough and flushed facies. In the respiratory system there were numerous medium-pitched inspiratory rhonchi at the left base. Soluble penicillin 500,000 I.U. twice daily was commenced. By the third day there were signs of collapse at the left base. On the sixth day chloromycetin 500 mg. every six hours was commenced, but she continued to deteriorate and died on the twelfth day.

Investigations: Sputum culture produced normal organisms. On the third day the white cell count was normal. An X-ray on the sixth day showed marked elevation of the left diaphragm.

At post-mortem there was consolidation of both lower lobes of the lungs, with an early broncho-pneumonic change on the right and older broncho-pneumonia on the left. Lung culture gave a very scanty growth of normal organisms. A lung section showed a patchy inflammatory process. The blood vessels were congested and the alveoli were filled with a fluid exudate, in which there were closely packed mononuclear cells. There was severe desquamation of the cells of the mucosa of the bronchioles, which contained a mucopurulent

exudate. The general cellular infiltrate was mainly mononuclear and hæmorrhagic, with focal collections of polymorphs.

CASE 2. A.S., aged 47, was admitted, complaining of pain in the left axilla of eight hours' duration. On examination her temperature was 103° F., pulse rate 128 per min. and respiratory rate 36 per min. She had a dusky flush and a dry cough. There were signs of consolidation of the left apex. Soluble penicillin 500,000 I.U. b.d. was commenced. Mucopurulent sputum with blood-streaking appeared later and there was a severe herpes labialis. The fever had subsided by the twelfth day and the patient had recovered by the twenty-first day.

Investigations: The sputum grew normal organisms. The white cell count was 7,000 per c.mm. on the ninth day. X-ray on the twelfth day showed consolidation of the left lung and after five weeks showed complete resolution.

CASE 3. V.M., aged 33. On examination her temperature was 103° F., pulse rate 126 per min. and respiratory rate 28 per min. She was flushed and had a dry cough. There were signs of consolidation in the right axilla. Herpes labialis developed on the third day. Chloromycetin 500 mg. every six hours was commenced. By the fourteenth day the patient was well with no abnormal physical signs in the chest.

Investigations: The sputum grew normal organisms. On the second day the white cell count was 21,200 per c.mm. with 91 per cent. polymorphs and the urine was positive for bile. X-rays on the fifth day showed consolidation of the posterior segment of the right upper lobe.

Discussion

A mounting awareness of and interest in the syndrome of primary atypical pneumonia was aroused during the war years and many papers were published. Reimann (1947) gives a comprehensive account of all the proven and presumed viral pneumonias and reviews the literature up to 1947. He concludes that the primary atypical pneumonias comprise a syndrome probably composed of a number of entities caused by a number of different agents.

No similar outbreaks in the British Isles have been traced. Stuart Harris (1950) states that primary atypical pneumonia is essentially sporadic. Herxheimer and McMillan (1942) reported an outbreak in a girls' school of an atypical influenzal pneumonia in which the pneumonia was preceded by an influenzal-like illness. Alton and Hickie (1948) in Eire reported all four members of a family and the attending physician contracting the disease. Stephens (1948) reports an outbreak in the army in Italy, and outbreaks have been described in New Zealand (West, 1951) and Japan (Troen, 1952). Wood (1956) has described an epidemic of virus bronchopneumonia in a boys' school. The outbreak described in this paper was characterised by its explosive nature, with abrupt clinical onset and the early appearance of pneumonic lesions. The presence of herpes labialis and a raised W.B.C. count in the majority of cases and of bile in the urine in three cases were unusual features.

On the available data it is impossible to assess the incubation period. Reimann (1947) in his review recorded estimates varying from five to twenty-six days, and varying estimates between six days and three weeks have been made (Jordan, 1949; Rusby and Smart, 1951; Olson, 1944). The onset has been variously described (Reimann, 1947). It has been described as abrupt

(McCutchan, 1947; Marie, 1950; Jennings, 1952) and as insidious (Ferguson, 1947; Adamson and Beamish, 1947; Jordan *et al.*, 1951).

Those patients able to talk complained of headache and chest pain, symptoms commonly reported in the literature. Troen (1952) noted severe headache in thirty-three of her forty-five cases and Jennings (1952) in 33 per cent. of cases; he also observed pleuritic pain in half to two-thirds of his cases. Robertson and Morle (1951) described chest pain in 58 per cent. of cases.

Reimann (1947) reports that in most series the temperature is usually remittent, less often persistently high or intermittent, falls by lysis, rarely by crisis, and persists for seven to eight days. West (1951) gives five to fourteen days as the duration of pyrexia.

In this outbreak seventeen patients had respiratory rates greater than 30 (of these seven were dyspnœic) and nineteen patients had pulse rates greater than 120. This is in contrast to most observations, tachypnœa and dyspnœa being rarely reported (Drew *et al.*, 1943). Much emphasis has been placed on a slow pulse rate (Dingle and Finland, 1942; Drew *et al.*, 1943; Dingle *et al.*, 1943; Young *et al.*, 1943; Curnen *et al.*, 1945; Caughey and Dudgeon, 1947; Ferguson, 1947). Of 200 cases observed by Adamson and Beamish (1947), 88 per cent. were noted to have pulse rates of less than 110.

The dusky flush and bright suffused eyes, a characteristic feature in this outbreak, are not commonly described. Wood and Felson (1946) mention a flushed face with slight cyanosis in their cases; Green and Aldridge (1942) report a flush in 28 per cent. and cyanosis in 11 per cent. of 110 cases. It is of interest that a similar facies was noted in the 1936-37 epidemic of influenza at Chatham (Stuart-Harris, 1938).

Reimann (1947) notes that: " The cough is unproductive, or productive of only slight amounts of mucoid or mucopurulent sputum in the early period. It is occasionally blood-streaked, rarely bloody or rusty." Caughey and Dudgeon (1947) reported blood-streaking in 28 per cent. of cases, McCutchan (1947) in 12 per cent. of sixty-nine cases. The pinkish tinge of the sputum noted in seven cases has also been reported by Goodrich and Bradford (1942).

The high incidence of herpes (twelve cases) is most uncommon; Reimann (1947) states that herpes is a rarity.

The most common and most striking physical sign on the first day of the disease was the presence of localised rhonchi: Painton *et al.* (1946) found the presence of localised rhonchi in the absence of crepitations, a most important sign. Various authors have reported different early signs, Reimann (1947) concludes that the earliest detectable signs are suppressed breath sounds and râles in the affected area. Karpel *et al.* (1945) found crepitations in 50 per cent. of their cases on admission. Marked consolidation, with its associated signs of bronchial breathing and changes in tactile vocal fremitus and vocal resonance, is rare (Young *et al.*, 1943; Dingle and Finland, 1942). Much emphasis has been placed on the presence of a normal or low white blood cell count, although leukocytosis has been reported (Reimann, 1947; McCutchan, 1947; Caughey and Dudgeon, 1947; Jennings, 1952). Young *et al.* (1943) consider the absence of a leukocytosis important in the differential diagnosis. Marie *et al.* (1950) and Jordan *et al.* (1951) found a leukocytosis later in the disease which Rusby and Smart (1951) have suggested may be due to secondary infection. In this

outbreak a leukocytosis was noted in a majority of patients on the first or second days of the illness. Contratto (1943), reporting a first day leukocytosis of 14,000 to 15,000 cells per c.mm., which falls to normal on the second day of the disease, suggests dehydration as causative.

Reimann (1947) states that the urine rarely shows changes other than albuminuria. Goodrich and Bradford (1942) and Needles and Gilbert (1944) report albuminuria in the severely ill. Goodrich and Bradford (1942), finding microscopic hæmaturia in 4 per cent. of 500 cases, thought it was due to the use of sulphonamides. No reports of the presence of bile in the urine have been found, although Adams *et al.* (1946) described urobilinogen in the urine in Q fever.

Cold agglutinins are reported by Reimann (1947) in an average of 59 per cent. of cases, varying from 0 to 90 per cent. in different studies. Jordan *et al.* (1951) consider a fourfold change in titre as significant. The titres obtained in this series are probably insignificant.

Many descriptions of the radiological changes have been given; Lewis and Lusk (1944) and Jordan *et al.* (1951) have attempted classifications. It has been pointed out by Caughey and Dudgeon (1947), Meiklejohn (1947), and Robertson and Morle (1951) that lesions lying behind the heart or diaphragm are often found if lateral views are taken. Unfortunately in this series lateral films of those patients with negative postero-anterior films were not taken. Syverton (1950) has reported transitory shadows.

One case with decreased translucency of the whole of the left lung probably corresponds to the veiling or ground-glass appearance noted by Reimann (1947) and described by Drew *et al.* (1943).

Reimann (1947), computing many series, found lower lobar involvement in some 80 per cent, and several lobes in 10 to 20 per cent. of cases, although Fleming *et al.* (1945) described a predilection for the mid and upper zones.

As noted above, no conclusions can be drawn as to the effectiveness of the antibiotics used. All observers agree that penicillin and sulphonamides are of no value (Reimann, 1947). Some authors have claimed that aureomycin is effective (Meiklejohn and Shragg, 1949; Rusby and Smart, 1951; Finland *et al.*, 1949), but Walker (1953) found no evidence for these claims.

Pleural effusion is reported as rare (Dingle and Finland, 1942; Fleming *et al.*, 1945). McDonald and Ehrenpreis (1946), in seventy-five cases, found X-ray evidence of a small collection of fluid in the costophrenic angle in nine. Jennings (1952) found pleural effusions in seven of an unclassified group of seventy-nine cases. The nature of the pleural fluid has only been reported once—Reimann (1947), who refers to it as being commonly clear and occasionally containing cells, predominantly leukocytes.

The post-mortem reports of Campbell *et al.* (1943) and Binford and Hanser (1944) may be added to the twenty necropsy reports summarised by Reimann (1947).

Summary

An outbreak of primary atypical pneumonia is described, in which, of 130 patients at risk in an institution for mental defectives, twenty-six developed an acute respiratory illness. Twenty patients had evidence of lung parenchymal

involvement which was confirmed by X-ray in fifteen cases. The constancy of the clinical picture is noted and an analysis of the clinical findings is presented. Notable features of the outbreak were its explosive nature and the high case incidence. Unusual findings were early leukocytosis and herpes labialis in a high proportion of cases. The post-mortem findings in one case are described.

I am indebted to Dr. J. M. Ledingham for much help and encouragement.

REFERENCES

ADAMS, A. B., STAVELEY, J. M., ROLLESTON, G. L., and HENLEY, W. E. (1946): *Brit. med. J.*, **1**, 227.

ADAMSON, J. D., and BEAMISH, R. E. (1947): *Canad. med. Ass. J.*, **56**, 361.

ALTON, B. G., and HICKIE, M. D. (1948): *Lancet*, **1**, 559.

BINFORD, C. H., and HAUSER, G. H. (1944): *Publ. Hlth. Rep. (Wash.)*, **59**, 1363.

CAMPBELL, T. A., STRONG, P. S., GRIER, G. S., and LUTZ, R. J. (1943): *J. Amer. med. Ass.*, **122**, 723.

CAUGHEY, J. E., and DUDGEON, J. A. (1947): *Brit. med. J.*, **2**, 684.

CONTRATTO, A. W. (1943): *New Eng. J. Med.*, **229**, 229.

CURNEN, E. C., MIRICK, G. S., and ZIEGLER, J. E., jun. (1945): *J. clin. Invest.*, **24**, 209.

DINGLE, J. H., and FINLAND, M. (1942): *New Eng. J. Med.*, **227**, 378.

DINGLE, J. H., ABERNETHY, T. J., BADGER, G. F., BUDDINGH, G. T., FELLER, A. E., LANGMUIR, A. D., RUEGSEGGER, J. M., and WOOD, W. B., Jr. (1943): *War Med. (Chicago)*, **3**, 223.

DREW, W. R. M., SAMUEL, E., and BALL, M. (1943: *Lancet*, **1**, 761.

FERGUSON, M. S. (1947): *Glasgow med. J.*, **28**, 187.

FINLAND, M., COLLINS, H. S., and WELLS, E. B. (1949): *New Eng. J. Med.*, **240**, 241.

FLEMING, J., LINDECK, E. W., EVANS, I. H. (1945): *Brit. med. J.*, **1**, 689.

GALLAGHER, C. D. and J. R. (1952): *New Eng. J. Med.*, **247**, 314.

GOODRICH, B. E., and BRADFORD, H. A. (1942): *Amer. J. med. Sci.*, **204**, 163.

GREEN, D. M., and ALDRIDGE, F. G. (1942): *Milit. Surg.*, **91**, 503.

HERXHEIMER, H. G. J., MCMILLAN, A. J. (1942): *Brit. med. J.*, **2**, 513.

JENNINGS, G. H. (1952): *Brit. med. J.*, **1**, 123.

JORDAN, W. S., Jr. (1949): *Amer. J. Hyg.*, **50**, 315.

JORDAN, W. S., Jr., ALBRIGHT, R. W., MCCAIN, F. H., and DINGLE, J. H. (1951): *Amer. J. Med.*, **10**, 3.

KARPEL, S., WAGGONER, I. M., and MCCOWN, O. S., Jr. (1945): *Ann. intern. Med.*, **22**, 408.

LEWIS, E. K., and LUSK, F. B. (1944): *Radiology*, **42**, 425.

LYGHT, C. E., and COLE, L. R. (1941): *Ann. intern. Med.*, **14**, 2246.

MCCUTCHAN, G. R. (1947): *Amer. J. Med.*, **3**, 323.

MCDONALD, J. B., and ENRENPREIS, B. (1946): *Ann. intern. Med.*, **24**, 153.

MARIE, J., MARQUEZY, R. A., and DEBRAY, P. (1950): *Semaine Hôp. Paris*, **26**, 2531.

MEIKLEJOHN, G. (1947): *Med. Clin. N.Amer.*, **31**, 1442.

MEIKLEJOHN, G., and SHRAGG, R. I. (1949): *J. Amer. med. Ass.*, **140**, 391.

NEEDLES, R. J., and GILBERT, P. D. (1944): *Arch. intern. Med.*, **73**, 113.

OLSON, B. J., and TRENTING, W. L. (1944): *Publ. Hlth. Rep. (Wash.)*, **59**, 1229.

PAINTON, J. F., HICKS, A. M., and HARTMAN, S. (1946): *Ann. intern. Med.*, **24**, 775.

REIMANN, H. A. (1947): *Medicine (Baltimore)*, **26**, 167.

ROBERTSON, P. W., and MORLE, K. D. F. (1951): *Brit. med. J.*, **2**, 994.

RUSBY, L., and SMART, J. (1951): *Tr. med. Soc. Lond.* (1948-1950), **66**, 320.

STEPHENS, J. W. (1948): *Lancet*, **1**, 703.

STUART-HARRIS, C. H., ANDREWES, C. H., and SMITH, W. (1938): Special Report Series, Medical Research Council, London, p. 27.

STUART-HARRIS, C. H. (1950): *Brit. med. J.*, **2**, 1457.

SYVERTON, J. T. (1950): *Dis. Chest*, **18**, 456.

TROEN, P. (1952): *Arch. intern. Med.*, **89**, 258.

WALKER, S. H. (1953): *Amer. J. Med.*, **15**, 593.

WEST, S. R. (1951): *N.Z. med. J.*, **50**, 571.

WOOD, P. (1956): *Brit. med. J.*, **1**, 711.

WOOD, W. H., Jr., and FELSON, H. (1946): *Ann. intern. Med.*, **24**, 904.

YOUNG, L. E., STOREY, M., and REDMOND, A. J. (1943): *Amer. J. med. Sci.*, **206**, 756.

CHRONIC PNEUMOTHORAX IN MARFAN'S SYNDROME

By S. K. Gupta and V. N. Sharma

From the North Middlesex Hospital, London

Commonly known as arachnodactyly, Marfan's syndrome consists of protean manifestations mainly seen in the musculo-skeletal and cardiovascular systems. There is an hereditary familial disorder of mesoblastic growth and it is characterised by an elongation of the fingers and the toes, thin facies, tall lean build, hypotonia, scanty subcutaneous fat, anomalies of lens and other parts of the eye, high arched palate, pigeon or funnel chest and dolicocephaly. Cardiac abnormalities, especially atrial septal defect and hypoplasia of the aortic media, are associated in 40-45 per cent. of cases. The following case merits description because of the occurrence of spontaneous pneumothorax.

Case Report

A boy aged 12 was admitted to the hospital on May 16, 1956, with a history of a blow on the right side of his chest ten days previously, followed by vomiting and confusion for a short while. He had been a mouth breather since infancy and admitted his inability to take part in school games owing to breathlessness, which he had noticed as long as he could remember.

Family History. There was no consanguinity of parents, the only brother was normal. A cousin was a mental defective.

Physical Examination. He had a triangular face with a vacant expression, very big ears and a left internal squint (Fig. 1) with irregular nystagmoid movement. The pupils were slightly dilated with sluggish light reaction, but there was no other ocular abnormality. He had a marked nasal voice. His palate was so high-arched that its roof could not be visualised by direct means. He had a dolicocephalic skull (*i.e.*, cephalic index 50, normal being 75-80 in Europeans). He was right-handed. His height was 63 inches, weight 107 lb., arm span 67 inches, pubis to ground 40 inches. Hand/height and foot/height ratios were 12·5 per cent. and 17 per cent. respectively.

He also had arachnodactyly, funnel-shaped chest and kyphosis with winged scapulæ. He had definite muscular hypotonia with a tendency to knock knee and flat foot. There was little subcutaneous fat. His cardiovascular system appeared normal although his blood pressure was elevated 150/90 mm. Hg). There was no evidence of coarctation of the aorta.

Investigations. X-ray on admission showed the presence of two localised pneumothraces, one over the apex and the other under the base of the left lung. The appearance, however, was suggestive of a chronic pathology (Fig. 2). Electrocardiagram, barium meal examination with follow-through and bronchogram were normal. A skull X-ray, however, showed oxycephaly with a very small deformed pituitary fossa.

(*Received for publication May* 24, 1957.)

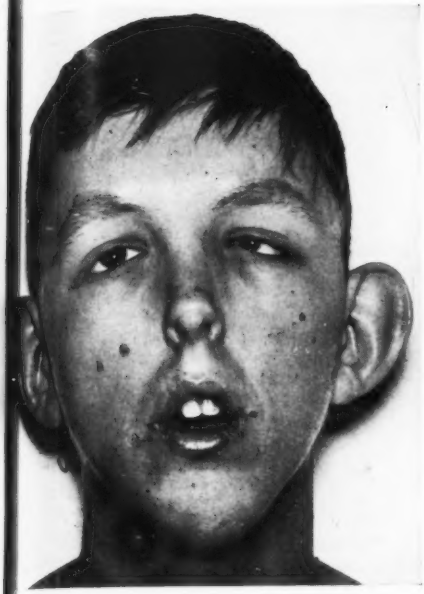


FIG. 1.—Vacant expression. Triangular face with very big ears. Left-sided internal squint and adenoid facies.

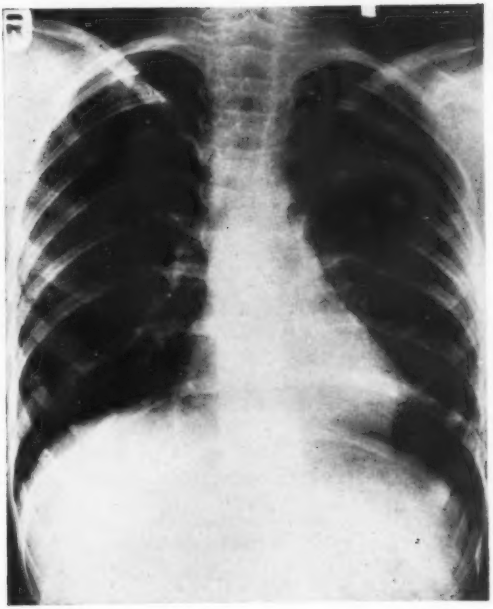


FIG. 2

FIG. 2.—X-ray on admission showing presence of two localised pneumothoraces. The appearance of overlying visceral pleura is suggestive of a chronic pathology.

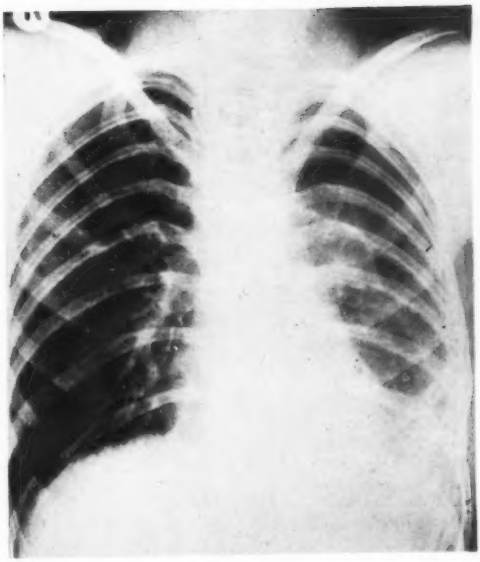


FIG. 3

FIG. 3.—Immediate post-operative X-ray showing absence of both pneumothorax spaces.

To face p. 346

Progress. The localised air spaces were closely watched for about six months, but there was no sign of spontaneous absorption, though the basal pocket disappeared temporarily, as a result of repeated aspirations. As the child was physically handicapped on account of slight but persistent breathlessness, he had a thoracotomy in January 1957 through the bed of the fifth rib. Many thick adhesions were severed and a decortication was carried out. There was no demonstrable air leak or any obvious pathology, but the underlying lung appeared rather fragile. The covering pleura was vascular and thick, implying chronicity. The appearance of the aorta was normal. He had a smooth immediate post-operative period. When seen three months after operation, he felt very much better and was not breathless any more. His X-ray now appeared virtually normal (Fig. 3).

Discussion

Since Marfan's (1896) original description more than 300 cases have been described (McKusick, 1955). Many new aspects of the syndrome have been added by various authors. Achard (1902) suggested an alternative title, "arachnodactyly," for the syndrome.

That our patient has Marfan's syndrome is beyond doubt. The relation of hand/height and foot/height ratios has been stressed by Whitfield *et al.* (1951), the upper normal limit being 11 per cent. and 15 per cent. respectively. Small and deformed pituitary fossa has also been described (Young, 1929).

The uncommon features noted in the present case are the presence of hypertension without any obvious pathology, internal squint in the left eye and dilated pupils (Rados, 1942).

The association of chronic spontaneous pneumothorax with Marfan's syndrome probably has not been recorded before. In the past, abnormalities in the lung (mostly on the left side) have been observed at necropsy as vestigial middle lobe (Boerger, 1915), and a single lobe on left side (Bergstand, 1943). According to Dimond *et al.* (1957), chest trauma may readily induce an acute exacerbation of symptoms and, in the present case, history and X-ray appearance suggested that the air leakage had been established spontaneously in the past. Brock (1948) has suggested a congenital ætiology in these cases. This association could well be fortuitous; but the fact that pulmonary anomalies have previously been described in Marfan's syndrome enhances the possibility of some interrelationship. A defect in the subpleural supporting tissue may be a manifestation of the generalised mesodermal disorder, resulting in an obvious pathological state like chronic spontaneous pneumothorax.

Summary

A boy of 12, with Marfan's syndrome, was admitted to hospital. X-ray revealed the presence of localised chronic spontaneous pneumothoraces and a thoracotomy was performed. The possible relationship of chronic pneumothorax and Marfan's syndrome is discussed.

Our thanks are due to Mr. Michael Bates for his permission to publish the case, and to Dr. R. J. Calvert for his helpful criticism.

REFERENCES

ACHARD, C. (1902): *Bull. Soc. méd. Hôp., Paris*, **19**, 834.
BERGSTRAND, C. G. (1942-43): *Acta paediat. (Stockh.)*, **30**, 345.
BOERGER, F. (1915): *Z. Kinderheilk.*, **12**, 161.
BROCK, R. C. (1948): *Thorax*, **3**, 8.
DIMOND, E. G., LARSEN, W. E., JOHNSON, W. B., and KITTLE, C. F. (1957): *New Engl. J. Med.*, **256**, 9.
MCKUSICK, V. A. (1955): *Circulation (N.Y.)*, **11**, 321.
MARFAN, A. B. (1896): *Bull. Soc. méd. Hôp., Paris*, **13**, 220.
RADOS, A. (1942): *Arch. Ophthal., Chicago*, **26**, 477.
WHITFIELD, A. G. W., ARNOT, W. M., STAFFORD, J. L. (1951): *Lancet*, **1**, 1378.
YOUNG, M. L. (1929): *Arch. Dis. Childh.*, **4**, 190.

RETURN TO WORK IN RESPIRATORY TUBERCULOSIS

By T. W. Davies and J. H. Thomas

From the Chest Clinic, Swansea

Introduction

Prior to the advent of anti-tuberculous chemotherapy much was written on the return to work of the tuberculous. Since then most publications have dealt with the treatment of the disease, and little has been written either on the duration of the illness or the time taken by the tuberculous to find work after being considered fit. The object of this paper is to assess these factors in relation to the effect of chemotherapy. Two periods were compared, and are presented.

Occupations Available

The Swansea Clinic is in an industrial area, and serves a population of 245,000. Coal mines and works dealing with iron, tin, copper, zinc, steel, aluminium and nickel are to be found. There is also a large oil refinery. A number of light industries are located in a trading estate and in other factories elsewhere. It is also a port. Other general occupations in shops, offices and schools and on the land are much as in other large towns surrounded by an agricultural community. There are also three Remploy factories and one Grenfell factory for the employment of the disabled.

No significant alteration occurred in the opportunities for work in the two periods studied, and the unemployment figure remained fairly stable at around 1-3 per cent.

Criteria of Fitness for Work

Although no hard-and-fast rule was followed, certain criteria were fulfilled before a patient was considered fit for work—sputum negative on culture three times at approximately monthly intervals, an unchanged radiological picture for at least six months, closure of cavities, and absorption or hardening of exudative lesions being essential. Attention was given to the psychological approach to work, and the general physical fitness was assessed with special reference to exertional dyspnœa and wheezing during ordinary activities. This information was correlated with the exertion necessary to perform the work and, where applicable, the amount of dust and fumes in the atmosphere at the place of work. No physiological tests of cardio-respiratory function were performed. Assessment in each case was purely clinical.

Patients were encouraged to make general inquiries regarding work two or three months before being declared fit. When work was found, details were obtained and its suitability discussed with the patient. Valuable information was thus obtained regarding the patient's attitude to work in general, his diligence in finding work, and also his ambitions. Those whose jobs had not been retained, and who were unable to find work without assistance, were referred to the Resettlement Officer, with whom problems relating to each case

(*Received for publication March* 12, 1957.)

were discussed. When necessary patients attended special centres for rehabilitation and re-training.

Survey Material

The two periods studied were 1945-47 (inclusive) and 1950-52 (inclusive). The follow-up in the first period was to June 1950, and in the second to June 1955. In each case, therefore, the follow-up period was from $2\frac{1}{2}$ to $5\frac{1}{2}$ years.

All the patients in the surveys were working when the disease was discovered, and only male patients between the ages of 16 and 59 years (inclusive) were considered. Those with pneumoconiosis, primary complex, pleural effusion and tuberculosis elsewhere were excluded, as well as those with other illnesses or physical disabilities which complicated return to work, such as hypertension, congestive failure, injured limb, blindness, severe deafness and mental instability.

In 1945-47, 157 patients satisfied the above criteria, and the corresponding number in 1950-52 was 156. Study of Table 1 (below) shows that the two groups are comparable, illustrating that the incidence in the male of adult-type respiratory tuberculosis had not materially altered during the years reviewed.

The type of disease, whether unilateral or bilateral, applies to the radiological appearance when the patient was first seen. Sputum examination, however, was regarded as positive when such a result was obtained on culture at any time during treatment.

Table 1.—Detail of Survey Material

	Total	16-39	40-59	*Unilateral*	*Bilateral*	*Positive Sputum*
1945 ..	57	37	20	18	39	40
1946 ..	57	36	21	14	43	48
1947 ..	43	29	14	16	27	39
	157	102 (65%)	55	48	109 (69%)	127 (80%)
1950 ..	67	43	24	22	45	60
1951 ..	50	37	13	19	31	42
1952 ..	39	23	16	16	23	25
	156	103 (66%)	53	57	99 (63%)	127 (81%)

Treatment

Treatment differed in the two periods, but the principles remained unchanged. Bed rest in the active stage was regarded as essential throughout. In the second series and in the last year of the first series it was supplemented by posture recumbency when cavitation was evident. Neither ambulant nor long-term chemotherapy was given during 1950-52. The routine treatment was 90 g. of Streptomycin, 1 g. daily, with PAS 18 g. daily. Surgery was undertaken throughout both periods, but the indications and the type of operation varied in accordance with the currently accepted views.

Details of active therapy will be seen in Table 2.

TABLE 2.—ACTIVE THERAPY PRACTISED DURING THE SURVEYS

Surgical procedures	1945-47		1950-52	
	16-39 yrs.	40-59 yrs.	16-39 yrs.	40-59 yrs.
A.P.	56 { 21	8* { 4	18 { 6	1† { 0
P.P.	16	2	5	0
Phrenic	19	2	7	1
Plasty	14	3	37	4
Lobectomy	0	0	8	1
Pneumonectomy	1	0	2	0
Seg. Res.	0	0	3	2
Monaldi	0	0	0	0
Cavity sewing	1	0	1	0
Extrapleural plombage	1	0	0	0
	Follow-up June 1950		Follow-up June 1955	

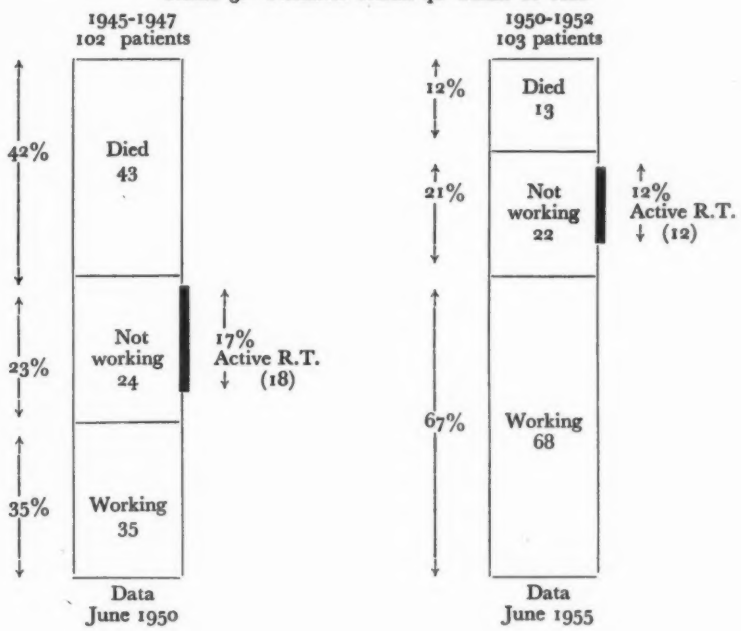
* No. pts. 62. No. died 16—26% † No. pts. 17. No. died 0

COMPARISON OF THE RETURN TO WORK OF PATIENTS 16-39 YEARS OF AGE

In 1945-47 there were 102 patients in this group and these were compared with 103 patients of the similar age groups in 1950-52 (see Table 3).

Mortality dropped from 42 per cent. to 12 per cent. and the number working in June 1950 and June 1955 respectively increased from 35 per cent. of the total to 67 per cent.

TABLE 3.—PATIENTS UNDER 40 YEARS OF AGE



The percentage not working was practically the same in both periods, being 23 per cent. in 1945-47 and 21 per cent. in 1950-52.

Further study showed that in the first period 17 per cent. of the total were not working because of active tuberculosis, whereas the corresponding figure in the second period was 12 per cent. It is disappointing that chemotherapy and surgery as practised during these years did not result in a greater reduction of the known infectious pool of respiratory tuberculosis.

Comparison of the Return to Work of Patients 40-59 Years of Age

Of 55 patients in 1945-47, 37 (68 per cent.) died by June 1950, whereas of 53 patients in 1950-52, 20 (38 per cent.) died by June 1955. The fall in mortality was, therefore, considerable, but less than in those under 40 years of age.

The percentage working in June 1950 and June 1955 increased slightly, from 25 per cent. of the total to 32 per cent., whereas the percentage alive but not working increased considerably, the corresponding figures being 7 and 30 per cent. (see Table 4).

Further analysis showed that in 1945-47 only 5 per cent of the total were not working because of active tuberculosis, while in 1950-52, 24 per cent of the total had active disease in June 1955, and therefore the known infectious pool of tuberculosis increased almost fivefold. A fall of 31 per cent. in mortality was accompanied by an increase of 19 per cent. in the carrier rate.

Many, or perhaps most, of the patients who would have died without chemotherapy were still unfit to return to work 2½-5½ years after diagnosis because of active tuberculosis. These patients received the recognised course of 90 g. Streptomycin with PAS, and our analysis shows that from the epidemiological standpoint the problem increased.

Long-term chemotherapy as practised to-day may have removed, or at least appreciably diminished, this danger, but statistical proof is necessary before this viewpoint can be finally accepted.

Comparison of Patients with Unilateral Disease

A comparison was made of 48 unilateral cases in 1945-47, 42 of whom were under 40 years of age, with 57 cases (43 under the age of 40) in 1950-52.

The mortality of 21 per cent. in the first series fell to 3·5 per cent. in the second (Table 5), and the two deaths in this period were not due directly to tuberculosis—one died from Hodgkin's disease and the other from a pulmonary embolus one month after thoracoplasty. No other patient died following surgery.

The percentage alive but not working diminished slightly, from 27 per cent. of the total to 22·5 per cent.; and the percentage working in June 1950 and June 1955 increased from 52 per cent. of the total to 74 per cent.

Comparison of Patients with Bilateral Disease

There were 109 patients with bilateral disease in 1945-47, and 99 in 1950-52 (see Table 6).

In the age group 16-39 years, 61 and 60 such cases occurred, while in the

TABLE 4.—PATIENTS OVER 40 YEARS OF AGE

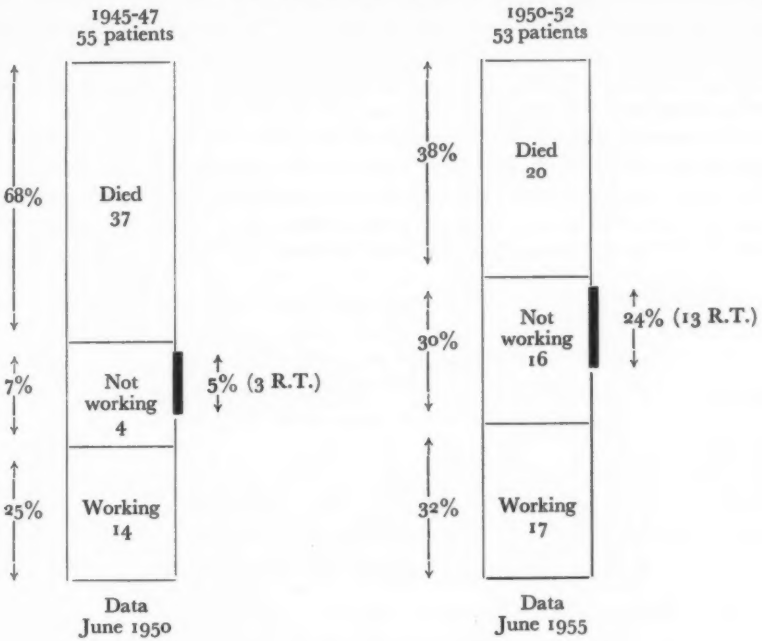
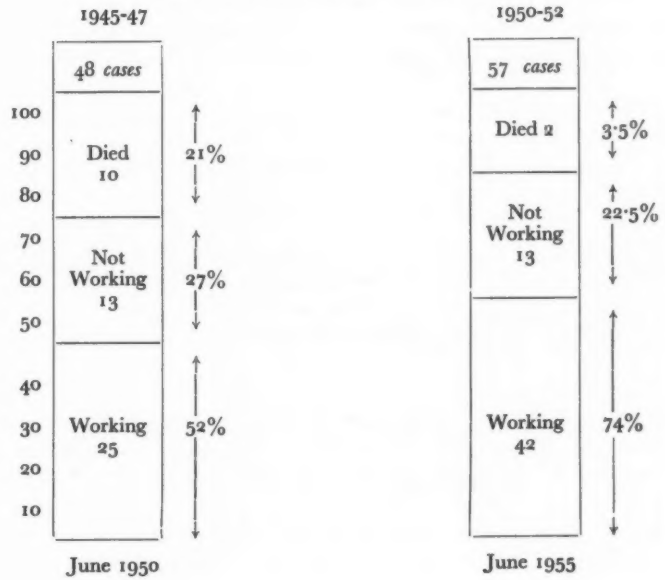


TABLE 5.—PATIENTS WITH UNILATERAL DISEASE



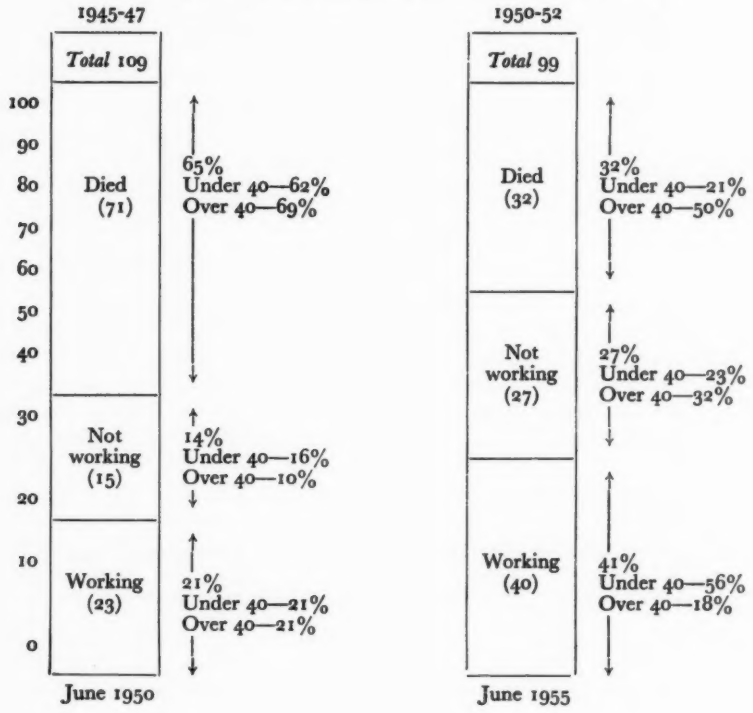
age group 40-59 years, there were 48 in the first series and 39 in the second. Bilateral disease was, therefore, more common than unilateral disease as a presenting manifestation in both age groups. Of the total 205 patients under 40 in the surveys, 121 (59 per cent.) had bilateral lesions when first seen. In the age group 40-59 years, 87 (80·5 per cent.) of the total 108 presented with bilateral disease (see Table 6).

A comparison of the two periods did not show any significant difference in the initial extent of the disease in those under 40 years of age. In the age group 40-59 years, however, the 87 per cent. presenting with bilateral disease in 1945-47 had diminished to 74 per cent. in 1950-52. There was a tendency, therefore, for the disease to be discovered at an earlier stage in this age group.

TABLE 6.—SURVEY MATERIAL OF UNILATERAL AND BILATERAL DISEASE

	Unilateral disease		*Bilateral disease*		*Total*
Age group:	1945-47	1950-52	1945-47	1950-52	
16-39 years ..	41	43	61	60	205
40-59 years ..	7	14	48	39	108
Total ..	48	57	109	99	313

TABLE 7.—DETAILS OF PATIENTS WITH BILATERAL DISEASE



The death rate was 65 per cent in 1945-47 and 32 per cent. in 1950-52. Reduction was marked in those under 40 years of age, the figures being 62 and 21 per cent. Over the age of 40 the difference was less, the mortality being 69 per cent. in the first period and 50 per cent in the second.

Investigation of the return to work showed that 21 per cent. of the patients in the first series were working by June 1950, while the corresponding number in the second series was 41 per cent. (see Table 7). The improvement was marked in those under 40 years of age, the relative figures being 21 and 56 per cent. In the 40-59 age group there was no significant change (21 per cent. in 1945-47 and 18 per cent in 1950-52).

The number alive but not working in June 1950 and June 1955 increased from 14 per cent. of the total to 27 per cent., the main increase being in patients 40 years of age and over. This contrasts with the findings in cases of initially unilateral disease (Table 5), where a slight decrease occurred.

Three months' chemotherapy had a beneficial effect in patients with bilateral disease, even in the older age group, but socially the result was disturbing as the number unable to work with 2½-5½ years increased.

Time taken to find Work after being declared Fit

The duration of unemployment was analysed in 69 patients, but in only 8 of the patients over 40 was there sufficient information for analysis, five having returned to their previous occupation within three months. In the age group 16-39 years inclusive, data was available in 61 cases. Twenty of these (32·7 per cent.) returned to their previous occupation within three months; 13 (21·3 per cent.) found work within six months; 8 (13 per cent.) within a year, so that 41 patients (67 per cent.) were suitably placed within a year of being declared fit for work. The remainder took considerably longer: 10 (16·4 per cent.) found work within eighteen months, 1 (1·6 per cent.) within two years, and one other within 2½ years, but 8 (13 per cent.) were still on the unemployment register despite the combined efforts of the patient, chest clinic and Labour Exchange.

A study on a regional or national basis would be of considerable value to the tuberculous patient, in that the problem would be more widely recognised and might lead to improvement in the facilities now available.

Analysis of those Working within Three Years of Diagnosis

The date of diagnosis and return to work was noted in each case, and a comparison made between the two periods in the survey. This was divided into the two age groups, 16-39 years inclusive and 40-59 years inclusive. The figures obtained can be compared with those in Tables 3 and 4.

(*a*) *Patients* 16-39 *Years Inclusive*

Of the 102 patients in 1945-47, 35 were working in June 1950, but of these only 22 (63 per cent.) returned to work within three years; while in 1950-52, 68 of a total of 103 were working in June 1955, and 51 (75 per cent.) within three years.

The time taken to find work was the same in each period, but the duration of the illness had diminished by an average of six months.

(*b*) *Patients* 40-59 *Years Inclusive*

In 1945-47, 9 of the total of 55 were working within three years. This is 64·3 per cent of those working in June 1950. The corresponding number in 1950-52 was 12 of a total of 53, 70·6 per cent. of those working in June 1955.

A comparison showed that the duration of illness had diminished slightly, but not to the same extent as in patients under the age of 40.

There is no definite evidence that prolonged chemotherapy, as practised today, will diminish the duration of the illness and make the patient fit for work sooner. Should surgery do this, then it should always be considered. We feel that improvement in the time-factor is not always given prominence when different therapeutic régimes are discussed. The danger of relapse is of paramount importance, and therefore a controlled investigation of this problem is necessary before our present treatment is substantially altered. In individual cases, however, it may be found that ambulant chemotherapy over several years may prevent relapse and enable patients to return to work sooner.

Discussion

In our analysis we compared patients with respiratory tuberculosis in two periods, 1945-47 and 1950-52, and showed that many who would have died without chemotherapy still had active disease 2½-5½ years later. Because of the short period of chemotherapy, viz. three months, the bacilli remained sensitive to the anti-tuberculous drugs. These two factors are important epidemiologically. With prolonged combined chemotherapy as practised to-day, more patients will be rendered sputum negative, but the emergence of resistant strains in some patients cannot be ignored. Cohn *et al.*, (1954) and Middlebrook *et al.* (1954) suggest that Isoniazid renders the bacillus less virulent by altering its chemical structure. In our experience this is true, but unfortunately in only a small percentage of patients so treated does the bacillus become completely catalase negative and avirulent to a guinea pig. Whether this means that such a bacillus is avirulent to man is debatable.

The chest physician not only has to treat tuberculosis, but has to see that the patient returns to suitable employment. Therefore, having obtained knowledge of the aptitude and skill of the patient, he has to work in close association with the Resettlement Officer of the Labour Exchange. In our series 13 per cent. of 61 patients between the ages of 16-39 years inclusive were unable to find suitable work within two and half years of being declared fit.

It is incumbent by Act of Parliament that industrial concerns employ 3 per cent. of disabled persons. The tuberculous are at a disadvantage because of the danger of relapse and infectivity. Placement by the Resettlement Officer would be easier if the regulations could be amended to ensure that a specific percentage of those disabled should be tuberculous.

Superannuation schemes at present often debar employment of the tuberculous because of the possibility of relapse. These schemes originated when tuberculosis had a high relapse rate. With modern treatment this risk is diminishing and many could now be accepted as first-class lives. Others, where in the opinion of the chest physician there is a doubt, could be given a period of probation.

A balanced effort should now be made to reduce the duration of the illness. With ambulant chemotherapy, many patients could perhaps return to work sooner than in the past without any appreciable increase of the danger of relapse. Patients who cannot return to their previous occupation could be referred to the Labour Exchange sooner, particularly in those areas where placement is difficult. The number returning to suitable work within three years of diagnosis was considered in the text. Even in the 16-39 age group in 1950-52, only 75 per cent. of those working were able to do so within three years. This includes the time taken to find work, but as 67 per cent. were placed within a year, the illness itself lasted on an average approximately two years.

We cannot visualise how the duration of the illness can be shortened in advanced unilateral and bilateral disease, using the drugs now available; but we agree with Todd *el al.* (1956) that the duration of pre-operative chemotherapy can be reduced in many cases without alteration in prognosis. This is applicable to limited disease where after three months' chemotherapy resection is considered necessary, to blocked cavities, tuberculomata and bronchial stenosis.

Indications for surgery vary, and each case has to be considered on its merits. Chemotherapy is the treatment of tuberculosis, and surgery an adjunct: both should be combined to make the patient fit for work in the shortest time.

Summary

1. A comparison of the return to work was made of 157 male cases of uncomplicated adult type respiratory tuberculosis in 1945-47 (inclusive) with 156 similar cases in 1950-52 (inclusive). Follow-up was to June 1950 and June 1955 respectively, and each series was divided into the two age groups 16-39 years and 40-59 years (inclusive).

2. In the age group 16-39 years, 35 per cent returned to work in 1945-47 and 67 per cent. in 1950-52. Seventeen per cent. were unfit to work because of active tuberculosis in the first series and 12 per cent. in the second, but the death rate fell from 42 to 12 per cent.

3. In patients over 40 years, 25 per cent. returned to work in 1945-47 and 32 per cent. in 1950-52. Five per cent were unfit to work in the first series because of active tuberculosis, and 24 per cent. in the second, although the death rate fell from 68 to 38 per cent.

4. The powers of the Resettlement Officer should be increased, and the regulations governing superannuation modified.

5. More attention should be given to the duration of the illness, and a greater effort made to enable the patient to return to work sooner.

We are grateful to Dr. G. Ll. Lewis for his collaboration in abstracting data, and to Professor F. R. G. Heaf for his criticisms. Miss E. Rosser is thanked for the secretarial work.

REFERENCES

Cohn, M. L., Kovitz, C., Oda, U., Middlebrook, G. (1954): *Amer. Rev. Tuberc.*, **70**, 641.
Middlebrook, G., Cohn, M. L., Schaeffer, W. B.: *ibid.*, page 852.
Todd, G., Teare, D., Gordon, W. I. (1956): *Lancet*, **2**, 1.

INTELLIGENCE AS A FACTOR AFFECTING THE DIAGNOSIS OF PULMONARY TUBERCULOSIS

By P. G. Arblaster and Marjorie Jessop

From the Chest Clinic, Warneford Hospital, Leamington Spa.

Introduction

Abundant sources of tubercle bacilli are responsible for the endemic nature of tuberculosis in England. Collectively they form the reservoir sometimes referred to as the "Infector Pool." Following antibacterial treatment pulmonary tuberculosis cases are usually not infectious and thus spread of disease must largely arise from unknown infectious persons.

Wittkower, Durost and Laing, 1955, suggested that intelligence is a factor

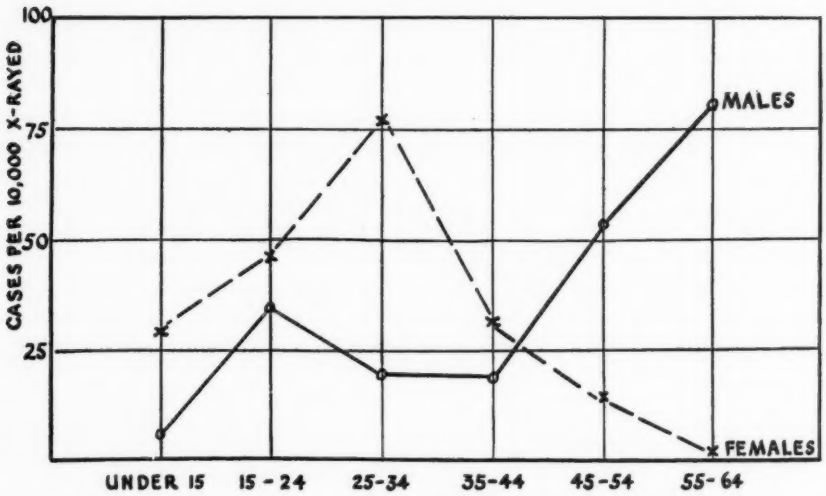


Fig. 1.—Tuberculosis yield from mass radiography surveys, Warwickshire, 1952-53 (35,828 cases).

related to extent of tuberculosis at diagnosis. We report simple tests of intelligence. They were made on patients with extensive tuberculosis, matched for control purposes with minimal disease cases.

Tuberculosis Morbidity

In 1952-53 the Warwickshire Mass Radiography Unit examined 35,828 persons. The result, as notified tuberculosis plotted in sex and age groups, is shown in Fig. 1. In each sex the peak rate was approximately 8 per thousand:

(*Received for publication May* 1, 1957.)

however, the age group for females was 25-34, while in striking contrast the male peak was in the 55-64 age group.

In 1950 the Chief Medical Officer of the Ministry of Health reported nearly three million mass radiography examinations made between 1943 and 1948.

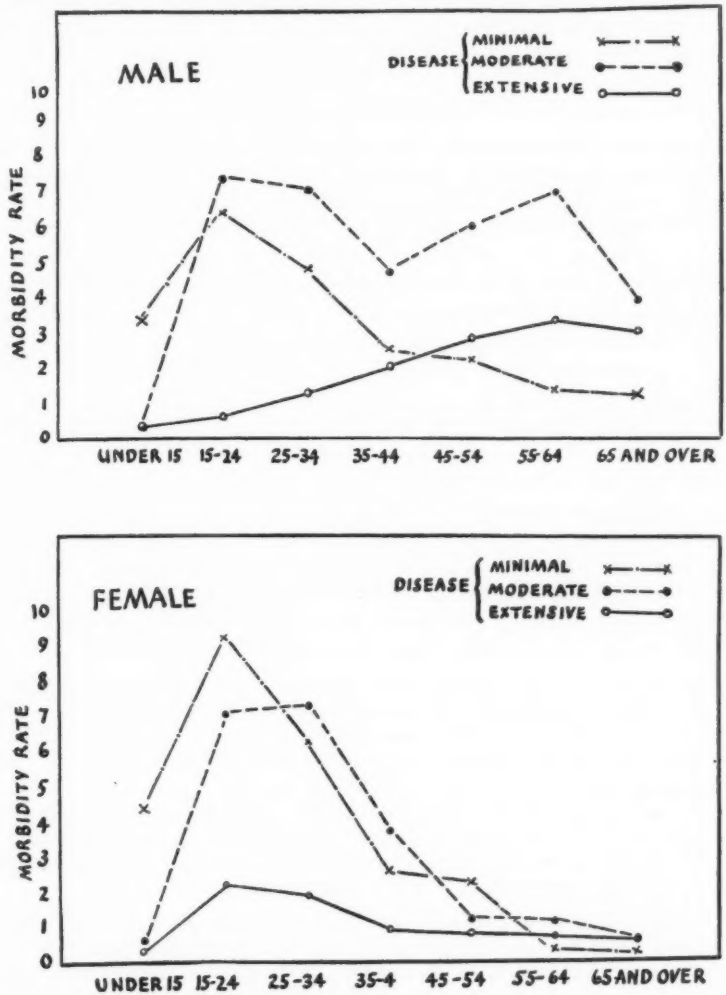


FIG. 2.—Classification of pulmonary tuberculosis cases, Warwickshire, 1952-53. By sex and age (894 cases).

The morbidity rates were a little lower than in Warwickshire, but the age distribution was similar. The male rate increased with age and the female rate decreased.

In 1952-53 the Warwickshire tuberculosis cases totalled 894. These were classified as having either minimal, moderate or extensive disease (see Appen-

dix) and are plotted by sex and age in Fig. 2. The average age of a sample of 166 cases in this series was minimal disease 28 years (43 cases), moderate disease 36 years (76 cases) and extensive disease 44 years (47 cases). The majority of infectious cases were classified as moderate or extensive. There were many more male than female patients with extensive disease and most of these were in the older age groups. Early diagnosis of pulmonary tuberculosis in the latter age groups is clearly of especial epidemiological importance.

Diagnosis in the Presence of Symptoms

The 166 cases discussed above were further analysed by number of symptoms and delay before diagnosis. By examination of clinical records and by questionnaires the time lapse between recognition of first symptom and medical consultation was estimated. On average the delay increased with extent of disease. There was no delay (*i.e.*, under one month) by 86 per cent. of patients with minimal disease who had on average $0{\cdot}9 \pm 0{\cdot}3$* symptoms (less than one because a proportion with no symptoms were diagnosed by mass radiography). Sixty-two per cent. of patients with extensive disease did not admit delay before diagnosis, yet they had on average $2{\cdot}4 \pm 0{\cdot}4$ symptoms; significantly more than the minimal disease patients. The remaining patients with extensive disease (38 per cent.) who admitted to delay (*i.e.*, more than one month) before medical consultation had $2{\cdot}8 \pm 0{\cdot}5$ or approximately the same number of symptoms as those patients with extensive disease who did not admit to any delay.

The profusion and manifest severity of symptoms in the patients with extensive disease suggested that they had either consciously or unconsciously denied a change in health until, gravely ill, they were induced to seek medical aid. This hypothesis, referred to by Wittkower in 1955, led us to test certain aspects of intelligence in minimal and advanced tuberculosis patients.

The following case histories illustrate some of these points:

Patient T.H., aged 40. Consulted General Practitioner concerning varicose veins. No other complaints. Trendelenburg operation 31.1.55. Readmitted 11.3.55 after an hæmoptysis; he then admitted to a cough, of which he had been aware for only five weeks. He was emaciated and daily produced 4 oz. of purulent sputum.

Chest radiograph: Large cavity occupying left upper zone. Considerable infiltration in rest of left lung and right upper zone. The patient died after six days. Relatives stated that his health had been deteriorating for months and that a cough had been present for nearly a year.

Patient D.M., aged 26. After months with a severe cough, sputum, considerable loss of weight and lassitude, he consulted a general practitioner who found a temperature of 102° F. and tuberculous bronchopneumonia involving all zones of the lungs. He required antibacterial drugs for three years. Previously, as a contact of a tuberculosis case he had refused several offers for a chest radiograph.

Plan of Experiment and Choice of Test

Only a limited number of patients with extensive disease were available for testing. It was not expected that deficiencies of mental capacity would be gross,

* ($\pm 0{\cdot}3$ is the confidence limit based on the size and amount of variation in the sample.)

and so, for statistical reasons, the test was made comparative. The comparison was a direct one between minimal and extensive disease patients matched by sex and age. Cases were selected from the Tuberculosis Registers of Leamington Spa and Coventry. All patients with extensive disease diagnosed in 1952-53-54 were tested, providing that a matching patient with minimal disease was available. There were insufficient matching patients over the age of 50. Random choice was made where more than one suitable matching patient was found.

By definition, extensive disease cases suffered constitutional upset (vide Appendix). The tests were performed after the elimination of all signs of toxæmia and for this reason two seriously ill patients were excluded. Five patients with extensive disease refused to attend and consequently their matching minimal disease patients were not tested. Eight patients with minimal disease refused to attend; these were replaced at random.

Two extensive disease patients were mentally incapable of completing the test; these and two patients who arrived intoxicated (one from each group) were excluded from the results. The details and distribution of these cases are listed in Table I.

TABLE I.—SELECTION AND DISTRIBUTION OF MATCHED PAIRS

Number of names initially selected		126
Number not available (in hospital, transferred out, dead)		30
Refused to attend:		
	Minimal disease (these were replaced)	8
	Extensive disease	5
Unable to complete test:		
	Minimal disease (replaced)—Intoxicated	1
Extensive disease	Intoxicated	1
	Mentally incapable	1
	Unable to write	1
Total excluded (not including 9 replaced minimal disease cases)		38
Total patients tested		88

Distribution of matched pairs

Area	*Male*	*Female*
Leamington	12	15
Coventry	11	6
Total pairs	23	21
Total patients	46	42

Eighty-eight patients completed the test. There were 23 male and 21 female pairs. Twenty-seven pairs were from Leamington Spa (these included some residents from rural districts) and 17 pairs from Coventry.

On the advice of a Clinical Psychologist, we used Raven's Progressive Matrices Sets A to E, 1938, and the Mill Hill Vocabulary Scale Set B Synonym Selection. The latter has a re-test reliability of 0·88 and correlates closely with verbal tests of " general intelligence."

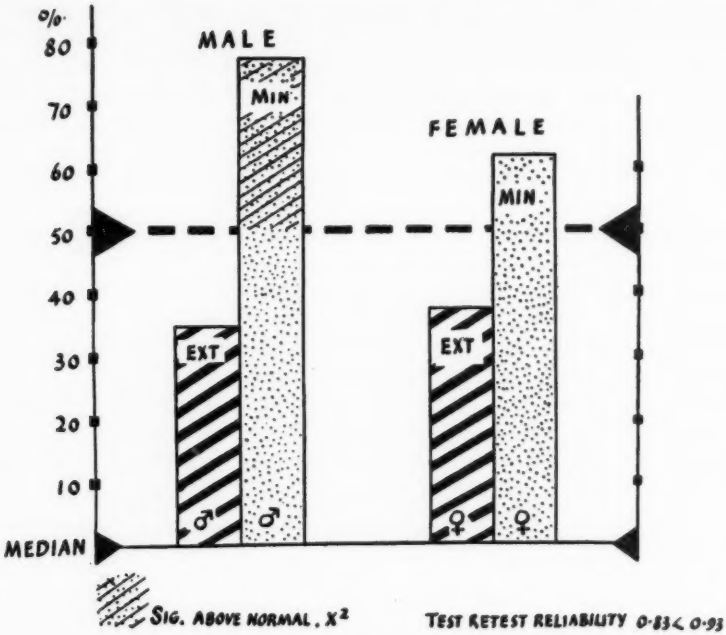


FIG. 3.—Matrices (1938) percentage above median score.

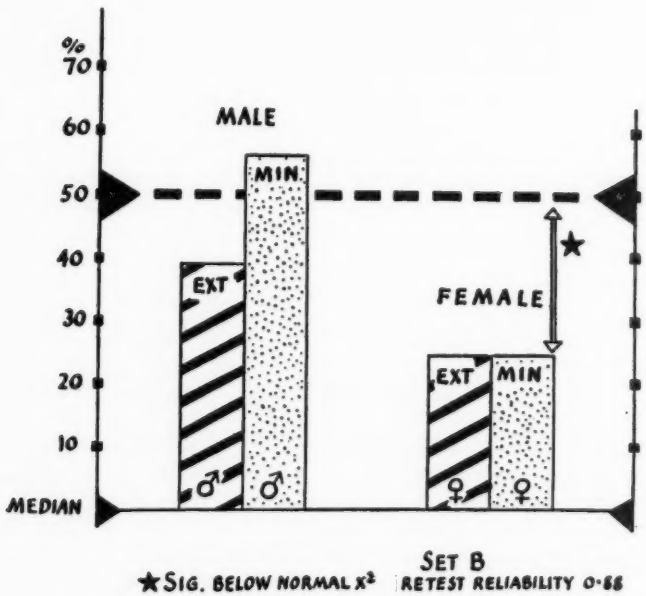


FIG. 4.—Synonym selection. Percentage above median score.

The following is an example. The synonym of recumbent is chosen from six words: fugitive, unwieldy, reclining, cumbersome, repelling, penitent. There are thirty-four series and the difficulty in selection progressively increases.

The progressive matrices are a test of a person's capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented, and, by so doing, develop a systematic method of reasoning.

The scale consists of 60 problems divided into five sets of 12. In each set the first problem is as nearly as possible self-evident. The problems which follow become progressively more difficult. The order of the tests provides the standard training in the method of working. The five sets provide five opportunities for grasping the method and five progressive assessments of a person's capacity for intellectual activity. To ensure sustained interest and freedom from fatigue, the figures in each problem are boldly presented, accurately drawn and, as far as possible, pleasing to look at. The contribution which each of the five sets makes to the total provides a means of assessing the consistency of the estimate and the psychological significance of discrepancies in the test results. The scale has a re-test reliability varying, with age, from 0·83 to 0·93. It correlates 0·86 with the Terman-Binet test, and has been found to have a G saturation of 0·82.

Males and females were tested in separate groups of approximately eight. To dispel apprehension and encourage co-operation, the test was discussed in a short introductory talk. A Clinical Psychologist explained the method of the test and invited queries. The Matrices test was completed first, then the Vocabulary test. There was no time limit. The papers were marked by an independent Clinical Psychologist unaware of the patient's name or extent of disease.

Results

(*a*) *Scores*

Following extensive tests on the population at large, tables of normal results, which varied with age, were constructed by Raven, 1938.

Results in the synonym test improve up to the age of 45, after which there is a slight fall. In the Matrices test there is a steady fall after the age of 25; for instance, it is expected that 50 per cent. of persons aged 20 will score more than 44 marks, whereas at the age 65 only 5 per cent. will achieve this level. There is a median score for each age group (50 per cent. score above and 50 per cent. below this value). In Table II the results in patients with minimal and extensive disease are expressed as percentages in relation to the median. (These are represented diagrammatically in Figs. 3 and 4.)

In the Matrices test the minimal disease male and female patients had higher than expected average (78 per cent. and 62 per cent. above median respectively) scores, while the extensive disease male and female patients had lower than expected (35 per cent. and 38 per cent. above median respectively) scores.

In the Synonym test the average score for minimal disease males was as expected (56 per cent. above median); the extensive disease males scored less

TABLE II.—MINIMAL AND EXTENSIVE PULMONARY TUBERCULOSIS AVERAGE SCORES RELATED TO MEDIAN VALUE IN PROGRESSIVE MATRICES (1938) AND SYNONYM SELECTION TESTS

Test	*Sex*	*Percentage above median score*		*Percentage below median score*	
		Extensive disease	*Minimal disease*	*Extensive disease*	*Minimal disease*
Matrices	Male	35	78*	65	22*
	Female	38	62	62	38
Synonym	Male	39	56	61	44
	Female	24*	24*	76*	76*

* Significantly different from the median, at 50, using the X^2 test.

than expected (39 per cent. above median). Both the minimal and extensive disease females scored significantly less than normal (each 24 per cent. above median).

(*b*) *Differences*

The patients tested were matched by age, and thus the difference between the scores in each pair can be regarded as actual. The average scores are shown in Table III, columns 3 and 4.

TABLE III.—MINIMAL AND EXTENSIVE PULMONARY TUBERCULOSIS, AVERAGE DIFFERENCES OF PAIRED PATIENTS IN THE PROGRESSIVE MATRICES (1938) AND SYNONYM SELECTION TESTS

Test	*Sex*	*Place*	*No. of pairs*	*Average score*		*Average score difference*	*Probability factor P*
				Minimal disease	*Extensive disease*		
MATRICES		(1)	(2)	(3)	(4)	(5)	(6)
	M	Leamington ..	12	45	32	13	0·005
		Coventry	11	45	35	10	0·025
		Combined ..	23	45	33	12	0·0005*
	F	Leamington ..	15	42	38	4	0·15
		Coventry	6	38	31	7	0·10
		Combined ..	21	41	36	5	0·075†
SYNONYM	M	Leamington ..	12	62	55	7	0·10
		Coventry	10	54	54	0	—
		Combined ..	22	59	55	4	0·20
	F	Leamington ..	15	52	52	0	—
		Coventry	6	47	46	1	—
		Combined ..	21	51	51	0	—

Highest possible score in Matrices = 60
Highest possible score in Synonym = 88

* Statistically significant.
† Borderline statistically significant.

The differences between the two groups of patients as a direct subtraction are shown in column 5. These differences have been analysed statistically, using the paired t-test, the probabilities are listed in column 6 and the figure shown is the probability that a difference as great as, or greater than that observed might have occurred by chance.

The results in Leamington Spa were very similar to those in Coventry. In the Matrices test the difference between the minimal and extensive disease male patients was statistically highly significant. The corresponding difference in female patients was indicative, but statistically of borderline significance. There were no statistically significant differences between the two series of patients in the Vocabulary test.

Discussion

In the Matrices test the difference between the two series of patients was statistically significant. This difference was accentuated by the excellent minimal disease results.

In the normal population the results of the Matrices and Vocabulary tests are similar. However, in each test different faculties are assessed and we are grateful to J. C. Raven for his help in the interpretation of our findings.

The Matrices differences, not present in the Vocabulary results, are probably not due to knowledge differences gained through school or adult occupation.

There are several possible explanations. The poor performances by extensive disease patients may be due to deficient intelligence or deficient will-to-achieve, and either or both of these may have been present before the onset of tuberculosis or may have developed as a result of the disease or of the emotional consequences of having the disease, or possibly of its treatment.

The actual scores of the minimal disease patients were statistically higher than those for the normal population. It is unlikely that the disease would have affected in opposite directions the test capacity of the two groups. General observation of those with extensive disease at diagnosis is that the impress of low intelligence or failure to employ available intelligence has been present for many years.

It has been shown that after the development of symptoms a high proportion of extensive disease cases delayed before consulting a doctor and this analysis has indicated that such patients have a reduced capacity for observation and clear thinking. It is perhaps these capacities which enable a patient to realise that he is not well and thus accelerate his decision to consult a doctor.

Acquired information, which was assessed by the synonym selection test, does not appear important, for the results were similar in the two groups of patients.

These tests have not shown that low intelligence persons are more likely than others to develop pulmonary tuberculosis, but that, when it does occur in persons with the intelligence deficiency recorded, the disease has frequently advanced to a serious extent before diagnosis.

Conclusion and Summary

Early diagnosis is especially important in middle-aged and elderly males who form the majority of the tuberculosis infector pool. Early doctor consulta-

tion probably depends upon certain mental faculties. There is a wide intelligence difference, as measured by the Matrices test, between patients with minimal and with extensive pulmonary tuberculosis. This may have a bearing upon early diagnosis and be relevant to case finding methods. It is possible that publicity appeals and educational information will have little effect upon many of those suffering from or likely to develop extensive tuberculosis. Epidemiological methods for early diagnosis may need re-orientation.

APPENDIX

Classification as defined in Memorandum 37/T (Revised), but the words " minimal," " moderate " and " extensive " have been substituted for Groups 1, 2 and 3 respectively.

Group 1—" Obvious physical signs and radiological findings should be of very limited extent. . . . Radiological findings should be limited to mottling involving a total area of not more than one zone. . . ."

Group 2—" All cases which cannot be placed in Groups 1 and 3."

Group 3—" Cases with profound systemic disturbance or constitutional deterioration and with marked impairment of function, either local or general. All cases with grave complications, whether they are tuberculous or not, should be classified in this Group (*e.g.*, diabetes, tuberculosis of intestine or larynx)."

We wish to thank Dr. Edward Stern, Dr. J. C. Raven and Miss E. A. Eatell for advice; Neville Irvine and Mrs. P. E. Crockert for practical help with the tests; and Miss Stella Newton for secretarial assistance.

REFERENCES

Annual Report of the Chief Medical Officer for 1950. H.M.S.O.

Raven, J. C. (1938): " Guide to the Mill Hill Vocabulary Scale with Progressive Matrices." London: H. K. Lewis.

Raven, J. C. (1938): " Guide to Progressive Matrices." London: H. K. Lewis 1954.

Wittkower, E. D. (1955): " A Psychiatrist looks at Tuberculosis." London: N.A.P.T.

Wittkower, E. D., Durost, H. B., Laing, N. A. R. (1955): *Amer. Rev. Tuberc.*, **72**, 201.

THE RESPONSE OF SPUTUM-POSITIVE TUBERCULOSIS IN THE COLOURED JAMAICAN TO HOSPITAL TREATMENT

By Richard A. S. Cory

King George V Jubilee Memorial Sanatorium, Liguanea, Jamaica

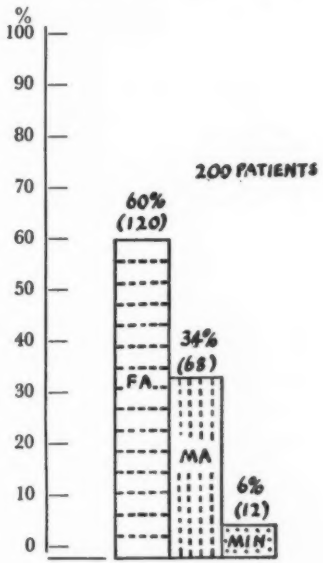
This paper is written with a view to presenting the results obtained in the treatment of sputum-positive, and therefore infectious, cases of pulmonary tuberculosis in the King George V Jubilee Memorial Sanatorium in Jamaica.

As it is concerned entirely with coloured patients in the lower income groups, those of white or Chinese origin have been excluded.

Table and Graph 1

(200 patients)

	No.	*Percentage*
Far advanced disease (F.A.)	120	60
Moderately advanced disease (M.A.)	68	34
Minimal disease (Min.)	12	6



The 200 patients on whom the results are being reported form two equal consecutive series of ward admissions, one for each sex, from the end of 1952 through 1955.

(*Received for publication May* 31, 1957.)

The only requirement for inclusion in the study was the possession of a positive sputum at the time of admission to the hospital.

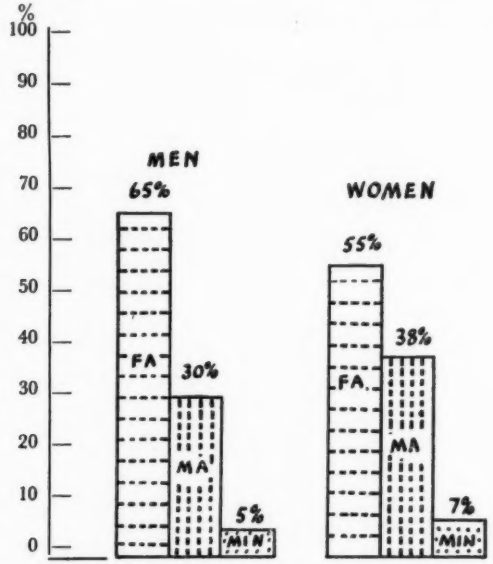
Extent of disease and the presence of pulmonary cavitation are entirely incidental, as the intention is to present the results as an overall picture of what has been accomplished by treatment in hospital in a group of infectious cases. Extent of disease, and the presence or absence of cavities at the start of treatment, are however of such importance that they have been analysed at the outset (Tables 1, 2 and 3) to establish a picture of the material on which the work has been done.

The 200 patients consisted of 100 males and 100 females, and they varied in age from 12 to 72 years. Using the classification standards of the National Tuberculosis Association, they fell on admission into three groups, Far Advanced, Moderately Advanced and Minimal disease. (Table 1.)

A breakdown of the total group into sexes is shown in Table 2.

TABLE AND GRAPH 2

	Men	*Women*
	%	%
Far advanced (F.A.)	65	55
Moderately advanced (M.A.)	30	38
Minimal (Min.)	5	7



The figures suggest that women tend to apply for treatment at a slightly earlier stage than do men, a finding which has been recorded on many occasions in other countries.

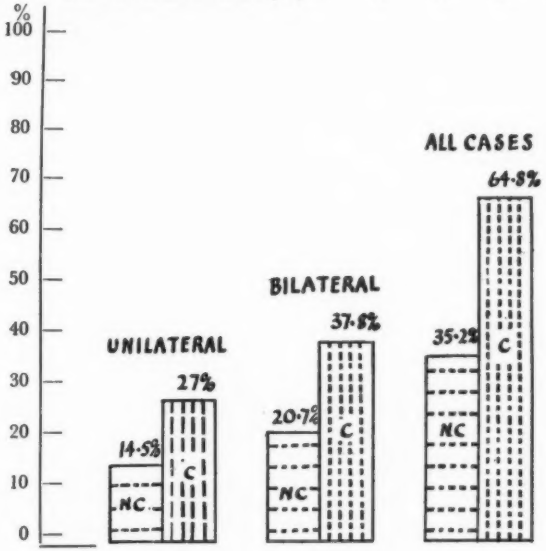
As prognosis depends to such a large degree upon extent of disease, whether or not bilateral, or the presence of cavitation at the start of treatment, these features have been briefly analysed in Table 3.

In the overall picture we find, therefore, that on admission 60 per cent. of the patients had far advanced disease, 34 per cent. moderately advanced disease, and only 6 per cent. minimal lesions. (Table 1.)

41·5 per cent. had disease in one lung only, while 58·5 per cent. had both lungs affected. Cavities were present in 64·8 per cent. of all patients. (Table 3.)

TABLE AND GRAPH 3.—TYPE AND EXTENT OF DISEASE

		%
Unilateral	No cavity (N.C.)	14·5
	One or more cavities (C.)	27
Bilateral	No cavity (N.C.)	20·7
	One or more cavities (C.)	37·8



TREATMENT

All but 3 cases received continuous long-term chemotherapy during their hospital stay. One of the three exceptions was moribund on admission and died four days later. The other two were started on rest and pneumoperitoneum and did so well that no drugs were ever used on them.

Most patients were treated with a combination of Streptomycin and Isoniazid at the outset (Table 4), and in 67·5 per cent. this carried them through the whole period of their treatment.

In 21·5 per cent. Para-amino-Salicylic Acid (PAS) was used together with Streptomycin and Isoniazid, on account of partial drug resistance as revealed by bacteriological studies.

Streptomycin and PAS at the beginning of treatment were used on some cavitary cases where there seemed to be a chance of early drug resistance appearing. In these cases Isoniazid was kept in reserve, either to combat appearing resistance or as a cover for subsequent surgery. Seven per cent. of patients were carried through to arrest on Streptomycin-PAS alone. Two

cases in the series (1 per cent.) were given Viomycin in addition to the other three drugs to cover pneumonectomy in the presence of general resistance to Streptomycin and Isoniazid.

Three cases (1·5 per cent.) received Isoniazid-PAS on account of total resistance to Streptomycin given before their admission.

Cycloserine and Pyrazinamide were not used, nor was single drug therapy ever used in this series.

We do not use drugs for less than nine to twelve months on cases of this type, and many of the patients received continuous therapy for more than two years.

In the sanatorium in Jamaica as a general rule we no longer use pneumothorax, pneumoperitoneum being employed instead when some degree of lung relaxation is needed. This form of treatment has in our opinion been of considerable value, particularly in cases of bilateral disease, where the better side can sometimes be improved to an extent that permits surgery on the worse side.

Of the 200 cases in this series 58 (29 per cent.) received pneumoperitoneum. In 43 of these (21·5 per cent.) it was the only form of treatment that was used in addition to drugs. (Table 4.) In 13 cases it was used as a preparation for surgery, and in 2 others it made drugs unnecessary.

During the last four years lung resection has gradually taken the place of thoracoplasty in our hospital, and most of our major surgery now consists of resections. Thoracoplasty, however, still has a place in the treatment of cases who are completely drug resistant, or whose bronchi, as revealed at bronchoscopy, are not in a safe condition for section.

Eight of the cases in this series (4 per cent.) were treated by thoracoplasty as the only major surgical procedure. Seventy-three of the patients (36·5 per cent.) were submitted to resections varying from pneumonectomy through lobectomies, to an occasional segmental or wedge resection.

Another 73 patients (36·5 per cent.) reached a good prognostic point, and were discharged, after rest and drug therapy alone, it being felt that there was no indication for surgical interference.

TABLE 4

Types of treatment used

Treatment	*No.*		*Percentage*
Rest only	1		0·5
Pneumoperitoneum (P.P.). No drugs	2		1
Drugs. No collapse or surgery	73		36·5
Drugs+P.P.	43		21·5
Drugs+thoracoplasty	8		4
Drugs+pneumonectomy	25		
Drugs+lobectomy	44	73	36·5
Drugs+segment or wedge	4		

Drug combinations used

Strep.+INAH	67·5
Strep.+PAS	7
Strep.+INAH+PAS	21·5
Strep.+INAH+PAS+Viomycin	1
INAH+PAS	1·5

Three patients received no drugs.

In brief, then, 36·5 per cent. of patients received drugs alone, 21·5 per cent. drugs and pneumoperitoneum, and 40·5 per cent. some form of major surgery. (Table 4.)

Results

For simplicity of analysis of the results after treatment I have used a classification for the cases finally discharged which rests upon the sputum status at the date of discharge. Patients with sputum repeatedly negative on culture of three-day pooled specimens, if sputum is present, or upon culture of gastric specimens, fall into the broad group "A."

This group is divided into four subgroups on the clinical and radiological assessment of the patient's condition thus:

A1. Arrested
A2. Apparently arrested } good prognosis.
A3. Course uncertain—uncertain prognosis.
A4. Likely to deteriorate—bad prognosis.

Those patients, and there are unfortunately a few of them, whose sputum has remained positive at the time of their discharge or transfer to another hospital have all been classified as " B," regardless of whether there is a likelihood of further improvement or not. This group carries a bad prognosis and has been classed as such in the analysis.

Two other groups have to be considered, namely those still in hospital at the time of observation, and those who have died in hospital.

An analysis of the results appears in Tables 5 and 6. (Table 5.)

TABLE 5.—RESULTS AS AGAINST STAGE OF DISEASE ON ADMISSION (PER CENT.)

Admitted as:		*Results*			*Remaining in hospital*	*Died in hospital*
		A1 and A2 Good prognosis	*A3 Uncertain prognosis*	*A4 and B Bad prognosis*		
Men	Far advanced	72·5	10·5	3	10·5	3
	Moderately advanced ..	83·3	3·3	13·3	—	—
	Minimal	100	—	—	—	—
Woman	Far advanced	83·6	7·3	—	7·3	1·9
	Moderately advanced ..	84	10·5	2·6	2·6	—
	Minimal	100	—	—	—	—
All Cases	Far advanced	77·5	9·2	1·6	9·2	2·5
	Moderately advanced ..	83·8	7·3	7·3	1·4	—
	Minimal	100	—	—	—	—

In Table 5 an attempt has been made to compare the stage of the disease on admission with the final result, separately for males and females.

In the men it will be seen that of those who came in with far advanced disease 72·5 per cent. did well and left hospital with a good prognosis. In the

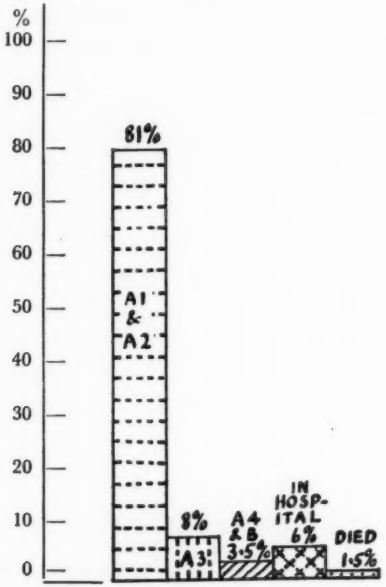
moderately advanced group 83·3 per cent. reached a good prognostic stage while all the minimal cases recovered.

In the women of the far advanced group the recovery rate was 11 per cent. higher than among the men (83·6 per cent.). Figures for the moderately advanced and minimal disease patients were almost exactly the same for the women as for the men. No deaths occurred in either of the last two groups in men or women. For the whole series of 200 patients the figures show 77·5 per cent. of the far advanced group with a final good prognosis. Those with moderately advanced disease did well in 83·8 per cent. of the cases. All minimals did well.

There were three deaths in the series. In one of these the patient was moribund on admission. One followed a pneumonectomy. The third was a man who showed no response to rest, drugs and pneumoperitoneum, and who died after 333 days in hospital. They were all far advanced cases. Twelve patients (6 per cent. of the series) were still in hospital at the period of observation, but of these, three have a good prognosis and should reach their discharge in time.

TABLE AND GRAPH 6.—STATUS OF PATIENTS AT PERIOD OF OBSERVATION

	Men	*Women*	*Totals*	*Percentage*
A1 and A2. Good prognosis	77	85	162	81
A3. Uncertain prognosis ..	8	8	16	8
A4 and B. Bad prognosis ..	6	1	7	3·5
Remaining in hospital ..	7	5	12	6
Died in hospital	2	1	3	1·5



Final results have been summarised in Table 6. From this it will be seen that of the original 200 patients 81 per cent. left hospital with a good prognosis,

having become either arrested or apparently arrested. Eight per cent. carried an uncertain prognosis at the date of their discharge, while 3·5 per cent. left with a bad outlook. One and a half per cent. died.

Reference to Table 6 will again reveal the fact that results in women can, on the whole, be expected to be slightly better than in men.

Of the 100 women in the series 85 per cent. left with a good prognosis, while of the 100 men 77 per cent. fell into the good prognosis group.

On the other side of the picture, however, there remains the fact that somewhere about 15 per cent. of patients are not going to do well in spite of all the treatment that we can offer them with our present knowledge.

Summary

This paper deals with the immediate results following hospital treatment with rest, drugs and surgery on a series of 200 consecutive ward admissions in the sanatorium in Jamaica from the end of 1952 through 1955. The patients all had positive sputum at the date of their admission to the sanatorium. Sixty per cent. suffered from far advanced tuberculosis, 34 per cent. from moderately advanced disease, and 6 per cent. from minimal lesions. Treatment varied according to the needs of the patient, and consisted basically of rest with long-term combined drugs, supplemented by surgery where necessary. Pneumoperitoneum was used in addition to rest and drugs in 29 per cent. of patients. Three of the 200 patients died in hospital, and 12—or 6 per cent.—remained in hospital at the date of observation. Of the patients discharged 77·5 per cent. of the far advanced group left with a good prognosis, and 83·8 per cent. of the moderately advanced group also left with a good prognosis. All minimal cases did well. On the whole, women did somewhat better than men. In the final analysis, of the original 200 patients 81 per cent. left hospital with a good prognosis, having become either arrested or apparently arrested. Eight per cent. carried an uncertain prognosis at the date of their discharge, while 3·5 per cent. left with a bad outlook. One and a half per cent of the series died.

THE DIAGNOSIS OF CHRONIC PULMONARY TUBERCULOSIS IN CHILDREN

By Stanley J. Steel and Dip Singh

From High Wood Hospital for Children, Brentwood, Essex

Introduction

Chronic pulmonary tuberculosis is a relatively rare condition in children and may sometimes fail to be recognised. It can be defined as the adult type of tuberculosis occurring in childhood and is also described by various authorities as post-primary, tertiary or reinfection tuberculosis. The course and prognosis of the condition, if treatment is delayed, are so different to those of primary tuberculosis that it is important to make the diagnosis as early as possible.

Children with this type of disease are admitted to High Wood Hospital for treatment from a wide area of south-east England, and this has afforded an opportunity to study a group of patients and examine the way in which the cases were first recognised.

Material

For the purpose of this study we have selected a group of 100 children diagnosed as having chronic pulmonary tuberculosis who were under 16 years of age on admission to High Wood. This group included all those patients in hospital in October 1956 and patients discharged consecutively during the preceding months until 100 cases had been collected. Eight patients were not considered because their radiographs were temporarily unavailable. Four others were rejected because of doubt as to the correct diagnosis, three in whom the lesion may have been primary tuberculosis and one where miliary tuberculosis was suspected.

Diagnosis

The typical radiological appearances of chronic pulmonary tuberculosis are those of ill-defined, diffuse or nodular infiltration, more often in the upper lobe and frequently of multiple or bilateral distribution, with or without cavitation. The shadows are usually quite different from those of a typical primary complex or a segmental lesion.

All our cases fulfilled these radiological criteria. The diagnosis was supported in the majority of patients (72 per cent.) by the presence of a healed primary lesion on radiography or a history of previous tuberculosis, including a known positive tuberculin skin reaction of not less than one year's duration (see Table I).

(*Received for publication May* 4, 1957.)

TABLE I

Calcified primary lesion visible on radiography		*History of previous T.B. without calcified primary lesion*	*Diagnosis based on radiological appearances only*
Without *history of previous tuberculosis*	With *history of previous tuberculosis*		
24	32	16	28

AGE AND SEX DISTRIBUTION

Forty of the patients were male and sixty were female. The age distribution is shown in Table II. There were no cases under 4 years of age.

TABLE II

Years:	4	5	6	7	8	9	10	11	12	13	14	15
Female ..	—	—	—	1	1	1	5	2	15	9	19	7
Male	1	—	—	—	2	1	3	2	6	8	12	5

BACTERIOLOGICAL RESULTS AND EXTENT OF DISEASE ON ADMISSION

Fifty-three patients had positive sputum or laryngeal swab cultures at some time during their illness. Twenty-one of these children with positive bacteriology were symptom-free. The extent of disease on admission according to the Ministry of Health Classification is shown in Table III.

TABLE III

A.1	*A.2*	*A.3*	*B.1*	*B.2*	*B.3*
37	8	2	18	22	13

CONTACT HISTORY

Sixty-nine patients had a history of contact with a known case of pulmonary tuberculosis, 55 within the home and 14 outside the home.

MEANS OF DISCOVERY

The means by which the cases were discovered included routine contact examinations, mass radiography (including B.C.G. schemes for school leavers), and radiography undertaken because of symptoms. The results are set out in Table IV.

TABLE IV

Radiography for routine contact examination	*Mass radiography of symptomless cases other then B.C.G. scheme*	*B.C.G. scheme*	*Symptoms leading to radiography*
40	14	7	39

Discussion

Age and Sex Distribution

Morgan (1934) reviewed 631 patients of less than 18 years of age with chronic pulmonary tuberculosis and found that there were more cases over 10 years of age than under and that there was a preponderance of girls over boys. Pope, Sartwell and Zachs (1939) followed up 400,000 Massachusetts children for ten years who were tuberculin tested. They concluded that significant tuberculosis in school children is infrequent below ten years of age and the incidence rises rapidly after this age and much more rapidly in girls than in boys. Macpherson (1943) found in a large follow-up of child contacts that lesions of adult type began to appear usually between 15 and 19 years of age. Bentley, Grzybowski and Benjamin (1954) studied a group of 116 children at High Wood with chronic pulmonary tuberculosis and found that 80 per cent. were 13 years of age or over and almost three-quarters of the cases were girls. Shaw and Wynn-Williams (1956) examined 293 children up to 14 years of age with respiratory tuberculosis and found 28 with " post-primary " lesions, of which 27 were in the age group 10-14 years and only one below 10 years of age.

In the 100 patients we reviewed, the majority were over 10 years of age, with a sharp increase at 12 years. There were 7 patients below 10 years of age and the youngest was 4 years old. The apparent drop in the number of 15-year-old children is probably due to the fact that children of this age are often treated in adult wards of hospitals or sanatoria so that a relatively smaller number are sent to High Wood. The proportion of girls to boys in our series was three to two, although the difference only occurred after the age of twelve.

Relationship to Primary Infection

Bentley *et al.* found radiological evidence of a calcified primary complex in 23 children among 116 patients with chronic pulmonary tuberculosis at High Wood. In the present, more recent, series, 56 had a calcified primary complex visible on radiography. The higher proportion among our cases was probably due to the greatly increased use of tomography. Thirty-two of these 56 cases had a history of previous tuberculosis or a positive tuberculin conversion more than one year previously, in addition to another 16 who did not show a calcified primary complex on radiography.

Contact History

Lloyd and Macpherson (1936) found that 40 per cent. of 1,000 patients 15-25 years old with chronic pulmonary tuberculosis had a history of contact. Pope *et al.* found that the morbidity among Massachusetts children with a history of family exposure was two and a half times that of children without known exposure. Bentley *et al.* showed that the incidence of chronic pulmonary tuberculosis falls most heavily on children who have been infected within the family circle.

In our series 55 had a history of contact within the home and 14 had a history of outside contact. These figures stress the importance of being aware that chronic pulmonary tuberculosis may possibly develop in children being followed up as contacts.

Means of Discovery

Davies (1955) found during a survey of 14-year-old school children in Edmonton that 3 of 800 children who had radiographs taken because of positive patch tests had chronic pulmonary tuberculosis. The majority of our series, 61 children, were picked up by mass radiography, including B.C.G. schemes for school-leavers, and by routine contact radiography. Only 4 of these admitted to having any symptoms and only one had symptoms of more than one month's duration. However, 53 of the patients had a positive sputum or laryngeal swab culture at some time during their illness, and 21 of these were symptom-free and were diagnosed by routine radiography. This potential source of danger to other school children underlines the need for more frequent Mantoux testing of school children (say, at 12 and 14 years of age) and radiological follow-up of the positive reactors.

Delay in Diagnosis

Our figures show that there was some delay in diagnosis before admission in 22 of the patients. Fourteen children, including one known contact, had symptoms of pulmonary tuberculosis of more than one month's duration. Six known contacts who developed chronic pulmonary tuberculosis were not followed up regularly and another 2 had a spread on a routine contact X-ray which was overlooked.

In children who are contacts, delay in diagnosis may occur owing to the child being discharged after the initial radiograph or a short period of observation. Sometimes the child may fail to attend or not be given regular appointments. Errors in reading the films occasionally occur and these may be reduced by double-reading as shown by Stradling and Johnson (1955).

In children with symptoms, delay in diagnosis is usually due to the relatives failing to seek medical advice at an early stage or the family practitioner not asking for radiological examination soon enough. It is suggested that symptoms of cough and lassitude persisting for more than three weeks should lead to radiography.

Even among children admitted to hospital with respiratory complaints the diagnosis may be delayed owing to lack of appreciation of the possibility of chronic pulmonary tuberculosis in this age group. Routine investigations in all such admissions should include tuberculin testing and search for the tubercle bacillus by direct examination and culture. However, the earliest lesion of C.P.T. is seldom bacilliferous and it is at this stage that the diagnosis should be made, even in the absence of positive bacteriological findings. Mistakes will seldom occur if the condition is always kept in mind, particularly at the susceptible age and especially in known contacts.

Summary

1. One hundred children under 16 years of age with chronic pulmonary tuberculosis treated at High Wood Hospital are reviewed.

2. The criteria of diagnosis, age and sex distribution, bacteriological results and extent of disease on admission, contact history and means of discovery are analysed.

3. The majority of patients were over 10 years of age with a sharp increase among girls at 12 years of age.

4. Seventy-two patients had evidence of previous tuberculous infection, including the presence of a calcified primary lesion on radiography, a history of earlier primary infection or tuberculin conversion more than one year previously.

5. Sixty-nine children had a definite contact history.

6. Sixty-one patients were picked up by mass radiography, including B.C.G. schemes for school-leavers and routine contact examination. Thirty-nine had symptoms leading to radiography.

7. Fifty-three patients had positive bacteriological findings, in whom 21 were symptom-free. A suggestion is made for more frequent tuberculin testing of school children and radiography of the positive reactors.

8. Delay in diagnosis may be prevented by greater appreciation on the part of both doctor and parents of the possibility of chronic pulmonary tuberculosis developing in children.

Our thanks are due to Dr. F. J. Bentley for instigating this investigation and for helpful criticism.

REFERENCES

BENTLEY, F. J., GRZYBOWSKI, S., and BENJAMIN, B. (1954): "Tuberculosis in Childhood and Adolescence." London: N.A.P.T.
DAVIES, J. V. (1955): *Tubercle*, **36**, 69.
LLOYD, W. E., and MACPHERSON, A. M. C. (1936): *Brit. med. J.*, **ii**, 1131.
MACPHERSON, A. M. C. (1943): *Brit. med. J.*, **ii**, 98.
MORGAN, R. (1934): *Amer. Rev. Tuberc.*, **29**, 577.
POPE, A. S., SARTWELL, P. E., ZACKS, D. (1939): *Amer. J. Pub. Health*, **29**, 1218.
SHAW, B., and WYNN WILLIAMS (1956): *Tubercle*, **37**, 243.
STRADLING, P., and JOHNSON, R. N. (1955): *Lancet*, **i**, 1247.

CORTICOSTEROID AND TUBERCULOSIS

By C. Y. Bland

From Springkell Sanatorium, near Johannesburg, Transvaal

The medical press (American Trudeau Society, 1952; Johnson and Davey, 1954; Editorial, *Lancet*, 1955; Bland, 1956) have made us aware of the possible recrudescence of inactive tuberculosis as a sequel to corticosteroid therapy. Paradoxically the corticosteroids are also helpful in the treatment of active tuberculosis (Ovedoff and Bensusan, 1953; Houghton, 1954; Climie, 1956; Cochrane, 1956; Handley, 1956; Harris, 1957), the paradox depending on the giving of tuberculostatic drugs at the same time.

At this sanatorium, during the last two years, thirty-nine male patients with active pulmonary tuberculosis have been given the corticosteroid, prednisolone, simultaneously with tuberculostatic therapy. The dosage of streptomycin was 1 g. daily (to the more seriously ill patients) or 1 g. three times a week; of INAH, 6-10 mg. per kg. of body weight daily: and of PAS, 12 g. daily. Two or three of these drugs were given at the same time. The dosage of prednisolone was 15 mg. daily, except for the very ill patients, to whom 20 or 30 mg. daily were given at first, this being later reduced to 15 mg. daily. The duration of the corticosteroid therapy varied from five to twenty weeks, except in two cases: (i) when hæmatemesis occurred after two weeks, and (ii) when a patient was deliberately given the drug for six months. The period since the cessation of the combined treatment in one case is two years: in ten cases, twelve to sixteen months: in twenty-seven cases, six to twelve months. One patient is still having the combined treatment, after two months, because of his hypersensitivity to the tuberculostatic drugs.

The patients were of three groups: (i) the hypersensitive, (ii) the acutely ill, and (iii) chronic cases.

(i) There were four patients in the hypersensitive group. They were ill with pyrexia, prostration, marked anorexia, anæmia and a high ESR. Their ages were from 31 to 49 years, and all had a history of short and sudden onset. All had *M. tuberculosis* in their sputum. As well as the characteristic mottling of fibrocaseous tuberculosis and the characteristic appearances of cavitation, the particular radiological features were dense opaque shadows and a ground-glass appearance. In terms of pathology, these shadows indicate a more œdematous exudation than is usual in fibrocaseous disease, and are read as signs of hypersensitivity (Kayne, Pagel and O'Shaughnessy, 1948). One patient also had a small pleural effusion, another sign of hypersensitivity (Rich, 1944). This effusion and the characteristic shadows in the lung fields of the four patients in this group disappeared within two to three weeks of the commencement of the combined therapy, although the mottling and translucency were still apparent. Rich (1944) points out that caseation and the "softening" of caseation with its resultant cavitation are not dependent on hypersensitivity.

(*Received for publication April* 30, 1957.)

The severe constitutional symptoms may be interpreted as part of the syndrome of the state of hypersensitivity (Rich, 1944) with toxæmia as a concomitant factor. These symptoms subsided within forty-eight hours in all four cases and did not recur. Three of the four patients had not had such a dramatic result with tuberculostatic therapy alone during the previous week. When the constitutional symptoms and the particular radiological shadows had gone, the disease regressed at a rate commensurate with tuberculostatic therapy alone. Hence it seems that the corticosteroid had acted only as a suppressor of the state of hypersensitivity, in the same way as it acts in other diseases associated with hypersensitivity. This would suggest that it is only in this limited respect that the corticosteroid assists tuberculostatic therapy in halting the progress of the disease. "The extent and destructiveness of a tuberculous lesion varies directly with the number and virulence of the bacilli and the degree of hypersensitivity" (Rich, 1944, p. 705).

(ii) There were nine acutely ill patients. All had positive sputum tests, and the disease had been present for at least six months. Their ages varied from 35 to 64. The radiological appearances were those of fibrocaseous disease with cavitation, and clinically they had pyrexia, anorexia, wasting, anæmia and high ESR. All had had tuberculostatic therapy before commencing the combined therapy. Within a week considerable clinical improvement was achieved by the addition of prednisolone to the drug therapy, but this lasted only as long as the corticosteroid was given. Undoubtedly the change from distressing symptoms to a feeling of well-being played some part in boosting the resistance of the patient to his tuberculous invader, but radiological improvement was no more than one would expect of the tuberculostatic drugs alone.

(iii) The chronic group: these twenty-six patients were all apparently well. Their ages varied from 45 to 67, excepting one aged 79, who was given prednisolone for allergic dermatitis, and another aged 32, who was given prednisolone because of his hypersensitivity to the tuberculostatic drugs. Fourteen have an unchanged positive sputum, none converted positive to negative, and twelve have an unchanged negative sputum. Radiologically, there were all varieties of chronic fibroid or fibrocaseous tuberculosis, showing cavities large and small, having thin walls and thick walls, and many were of the tension type. All had had tuberculostatic therapy for periods of two months to twelve months before the addition of the corticosteroid. In none did the disease show any dramatic improvement. Where improvement did occur (in thirteen patients), it was no more than was to be expected from the use of tuberculostatic drugs alone. Alternatively, no worsening of the disease occurred during or after the combined therapy, except in the case of the patient who was given the combined therapy for six months. His disease showed radiological worsening three weeks after the cessation of combined treatment.

Three of this group of patients could not be given tuberculostatic drugs. Two had no gastric tolerance of PAS and had a neuropathy following INAH therapy. The third had been shown to suffer a severe dermatitis when streptomycin, INAH and PAS were given. When prednisolone was added to these drugs, all three patients had none of the previously proved reactions and the neuropathy was not increased.

The tubercle bacilli of two patients were completely resistant to streptomycin, INAH and PAS before the combined therapy was given. Their disease did not worsen during or after this therapy.

Fourteen patients of this group had radiological evidence of silicosis. The corticosteroid had no apparent effect on this disease. There was no definite impression that attacks of bronchitis were less frequent.

Summary

It is suggested that, in tuberculosis, the use of corticosteroid with tuberculostatic therapy has no other purpose than

(i) to suppress the state of hypersensitivity to the bacillus or its products.
(ii) to suppress hypersensitivity of the patient to the tuberculostatic drugs.
(iii) to improve indirectly resistance by ameliorating the stress of toxæmia.

I am indebted to Dr. M. A. Pringle, the Medical Superintendent of Springkell Sanatorium, for his permission to publish these cases.

REFERENCES

Bland, C. Y. (1956): *S. Afr. med. J.*, **30,** 615.
Climie, H., *et al.* (1956): *Brit. J. Tuberc. Dis. Chest*, **3,** 265.
Cochrane, J. B., *et al.* (1956): *ibid.*, **3,** 269.
Editorial (1955): *Lancet*, **2,** 1071.
Handley, A. E. (1956): *S. Afr. med. J.*, **30,** 1250.
Harris, L. H. (1957): *Brit. J. Tuberc. Dis. Chest*, **1,** 98.
Houghton, L. E. (1954): *Lancet*, **1,** 595.
Johnson, J. R., and Davey, W. N. (1954): *Amer. Rev. Tuberc.*, **70,** 623.
Kayne, G. G., Pagel, W., O'Shaughnessy, L. (1948): " Pulmonary Tuberculosis." Oxford.
Ovedoff, D. L., and Bensusan, A. D. (1933): *S. Afr. med. J.*, **27,** 613.
Rich, A. R. (1944): " The Pathogenesis of Tuberculosis." Thomas.
The Committee on Therapy of the American Trudeau Society (1952): *Amer. Rev. Tuberc.*, **66,** 254.

THE USE OF ANTRENYL IN GASTRO-INTESTINAL IRRITATION DUE TO PAS COMPOUNDS

By Paul B. Woolley

From the Thoracic Unit, Monsall Hospital, Manchester

Since Lehmann introduced para-amino-salicylic acid in 1946 for the treatment of tuberculosis innumerable irritant and toxic side-effects have been reported. Fortunately, the more severe reactions such as hepatitis and exfoliative dermatitis are relatively rare. Gastro-intestinal irritation is extemely common, however, and frequently interferes with the administration of the drug. The Medical Research Council Trial (1950) reported that 24 per cent. of their cases complained of vomiting and 33 per cent. of diarrhœa, and in Nagley and Logg's (1949) patients 22 out of 37 had digestive upsets. Some degree of anorexia may be an even commoner complaint. The degree of irritation of the gastro-intestinal mucosa is undoubtedly related to the dosage, and it would appear that of the calcium and sodium salts the latter are the greater offenders. The large number of preparations of PAS on the market is one facet of the effort to relieve this irritation.

This paper deals with an attempt to combat these alimentary disturbances by administering Antrenyl with the PAS compounds. Antrenyl, known also as oxyphenonium bromide, acts by blocking the effect of acetylcholine on parasympathetic nerve-endings. It is a potent anti-cholinergic drug which relieves spasm and hypermotility. Its action is of longer duration than that of atropine and related compounds; thus on the rabbit's intestine it has a greater spasmolytic effect than atropine (Plummer *et al.*, 1953). Gastric motility is reduced considerably and this can be proved by comparing the time the stomach takes to empty following a dose of Antrenyl and a placebo (Mattmann and Strutner, 1953). The usual dosage is 5 mg. three or four times daily, but double this amount is permissible. Single doses of 25 mg. can produce xerostomia but not mydriasis. Antrenyl has been reported on extensively in the treatment of peptic ulceration by various authors (Rogers and Gray, 1952; Rowen *et al.*, 1953).

Investigation

The patients were treated with either PAS 16 g. daily or Therapas 14 g. daily, in combination with either streptomycin or isoniazid. All those who complained of gastro-intestinal irritation were placed in one of two groups: Group A comprising 18 patients, 13 men and 5 women, who were given the above therapeutic régime plus Antrenyl 5 mg. four times daily by mouth. The Antrenyl was administered at the same time as the PAS (time of administration is probably immaterial). Group B (control) comprising 9 patients, 6 men and 3 women, who were given the same régime plus four inert tablets daily instead of the Antrenyl.

(*Received for publication June* 14, 1957.)

The following table summarises the results in Group A:

No. of patient	*Drug*	*Main complaint*	*Result*	*Comments*
1	PAS	Anorexia and nausea	Complete relief	
2	PAS	Anorexia	Return of appetite	Antrenyl suspended
3	Therapas	Anorexia	Return of appetite	Antrenyl suspended
4F	PAS	Nausea	Some relief	Antrenyl suspended
5F	PAS	Nausea and vomiting	No relief	
6	Therapas	Anorexia	Return of appetite	
7F	Therapas	Anorexia and nausea	Some relief	
8	Therapas	Nausea and heartburn (Large hiatus hernia)	Complete relief	
9	PAS	Nausea	Complete relief	Antrenyl suspended
10	Therapas	Anorexia and nausea (known duodenal ulcer)	Complete relief	
11	PAS	Nausea	Complete relief	Antrenyl suspended
12	PAS	Anorexia	Return of appetite	Antrenyl suspended
13	PAS	Colic and diarrhœa	Relief	Antrenyl suspended
14F	PAS	Nausea and retching	Considerable relief	
15	PAS	Anorexia	Return of appetite	
16	Therapas	Nausea and anorexia	Complete relief	
17F	Therapas	Anorexia	Return of appetite	Antrenyl suspended
18	Therapas	Slight diarrhœa	Complete relief	

Discussion

From the above table it can be ascertained that the results were almost uniformly good with Antrenyl. No patient in the control group derived any benefit from the inert tablets. There is little doubt that PAS preparations are fairly strong gastro-intestinal irritants and that this irritation can be neutralised by giving Antrenyl. Beyond a slight dryness of the mouth in 4 patients no unpleasant side-effects were encountered. In 8 patients with only mild gastro-intestinal irritation it was possible to suspend the Antrenyl after a week or so without the irritation returning. Some patients have now been on Antrenyl for four months.

There is little doubt that many patients on domiciliary treatment reduce the dosage of PAS on their own initiative. The considerable danger which may ensue—to the patient himself and to others—is only too obvious. By prescribing Antrenyl they can be persuaded to keep up with the requisite dosage. The anti-cholinergic drugs have been administered for periods up to

eight months to cases of peptic ulceration and no significant toxic effects are to be expected (Rowen *et al.*, 1953). On no account, however, should they be prescribed for patients with glaucoma and close supervision is necessary in cases of prostatic hypertrophy and pyloric stenosis.

Summary

1. Eighteen patients suffering from gastro-intestinal irritation due to PAS compounds were treated with Antrenyl.

2. Antrenyl is effective in relieving this irritation.

I should like to thank Dr. William Robinson for his encouragement in this investigation and Sister Glover for her help with the patients. I am grateful to Ciba Laboratories for supplying the Antrenyl tablets.

REFERENCES

Dixon, W. M. (1954): *Brit. J. Tuberc. Dis. Chest*, **48**, 102.
Mattmann, P. E., and Strutner, L. (1953): *Amer. J. dig. Dis.*, **20**, 126.
M.R.C. (1950): *Brit. med. J.*, **2**, 1073.
Nagley, M. N., and Logg, M. H. (1949): *Lancet*, **1**, 913.
Plummer, A. J., Barrett, W. E., Rutledge, R., and Yonkman, F. F. (1953): *J. Pharmacol.*, **108**, 292.
Rogers, M. P., and Gray, C. L. (1952): *Amer. J. dig. Dis.*, **19**, 180.
Rowen, B. R., Barach, W. H., Halstead, J. A., and Shapiro, H. (1953): *Gastroenterology*, **24**, 86.

CARCINOMA OF THE BRONCHUS IN A CENTENARIAN

REPORT OF A CASE

By Trevor H. Howell

Queen's Hospital, Croydon, Surrey

Carcinoma of the bronchus is being diagnosed more and more frequently. Its incidence seems greatest during later middle age among males. Nevertheless, this neoplasm may occur even among the aged. A recent series of 300 cases verified at necropsy showed 13 per cent. in the seventies and 2 per cent. in the eighties. The oldest patient was a male aged 85, who showed a secondary deposit in one suprarenal gland. Since the paper describing these findings was sent to press, I have encountered an even older case of carcinoma of the bronchus in a woman of 101 years.

Mrs. E. C. was admitted to Queen's Hospital, Croydon, on account of age and infirmity. On examination there were few abnormal signs, apart from a painful right shoulder. She was rather deaf, but mentally clear and not incontinent. An X-ray of her chest showed small scattered irregular markings in the lungs and a calcified patch at both apices. She gradually became weaker and died ten months after admission with signs of consolidation in the right lung.

At necropsy the body was that of a thin old woman, with a sacral bedsore. The heart was very small and showed brown atrophy. The kidneys were finely granular, having some small calculi present in the pelves. Liver and spleen were small and congested. The gut was normal. Bilateral hydrothorax was present. The lungs showed old apical scarring with calcification. There were numerous shotty nodules scattered throughout both lower lobes. The right base showed a terminal pneumonia. The right suprarenal gland showed a rounded nodule, occupying most of the organ. The remainder of the body tissues appeared normal for the age of the subject. The provisional conclusion was a terminal pneumonia as the cause of death.

Histology of the sections taken from the lungs showed, however, that the nodules were composed of bronchial adenocarcinoma, widely disseminated. The mass in the suprarenal was a secondary deposit of the tumour.

Summary

Necropsy on a woman of 101 revealed the presence of carcinoma of the bronchus. This would seem to be the oldest case so far recorded.

My thanks are due to Dr. C. O'Connor for her help with the pathology of this case.

REFERENCE

Howell, T. H., and Piggot, A. P. (in press).

(*Received for publication March* 19, 1957.)

REVIEWS OF BOOKS

Chronic Bronchitis in Newcastle upon Tyne. By A. G. Ogilvie, M.D., F.R.C.P., and D. J. Newell, M.A. Edinburgh: E. and S. Livingstone Ltd. Pp. 115. 15s.

Dr. Ogilvie and his colleagues are to be warmly congratulated upon carrying out the first field survey on the prevalence of chronic bronchitis in a large community. Their technique was to select every fortieth house on the Voters' List in Newcastle upon Tyne and to interview all the occupants over the age of 30. This involved questioning 3,685 persons, and only 4 per cent. of the selected sample failed to give complete information. Amongst those who were suspected of having bronchitis, 1,202 also had physical and radiological examinations.

The rough clinical diagnosis consisted of a cough and sputum continuously for at least three months during not less than two years. This meant that very high prevalence rates were obtained, namely 36 per cent. for males and 17 per cent. for females. By adding the symptom of breathlessness, these figures were reduced to 21 per cent. and 14 per cent. respectively, which are more in line with the experience of others.

The inquiry embraced many possible ætiological factors, from which it appeared that bronchitis was not particularly related to personal domestic care, housing or occupation. On the other hand, bronchitis did seem to be related to a family history of allergy and to prolonged residence in sooty, damp and foggy surroundings.

The enormous amount of work involved in this survey can only be appreciated by studying the text. The colloquial style makes the volume eminently readable. For example, excessive mucus is regarded as enabling bacteria " to maintain themselves in comfort " within the bronchi; on another page, the accepted diagnoses were chronic bronchitis, with and without asthma, and " other things." The discriminating reader will obviously wonder what these " other things " comprise in Newcastle, and may even feel that he has been cheated of some erudite syndrome hitherto undescribed. This book is well produced, but the references contain an unfortunately large number of misprints. A thoroughly interesting and entertaining report.

Neville Oswald.

A Synopsis of Children's Diseases. John Rendle-Short, M.A., M.B., B.Chir., M.R.C.P., D.C.H. 2nd edition. Bristol: John Wright and Sons Ltd. Pp. 632. 35s.

Medicine, or the art of looking after patients, cannot be satisfactorily learnt from synopses. They can, however, be very useful as aids to those preparing for examinations, and are valuable for easy and quick reference. This book by Dr. Rendle-Short is of a standard unusually high for these purposes. It is fortunate that suitable prominence is given to common *early* signs and symptoms. Most of the comments on treatment are very sensible.

So long as candidates for (perhaps) the examination for the Diploma in Child Health are going to be asked many short questions about different diseases, books of this nature are going to be bought. It is accordingly satis-

factory that in this, the second edition, many of the minor defects of the first have been removed.

The sections on hay fever and asthma deserve special mention. For example, it is pointed out that desensitisation is not commonly of value. It is, of course, impossible to present detailed advice about the psychiatric aspects of a disease in two or three lines, but the few sentences devoted to this, the most important part of management, are indeed to the point.

THOMAS STAPLETON.

Symposium of Tuberculosis. Edited by Professor F. R. G. HEAF. London: Cassell and Co. Ltd. Pp. 755. Illus. £5 5s.

Before this book came into his hands your reviewer would have had very considerable doubts whether there was any place for another large book on Tuberculosis. Perusal of Professor Heaf's book, however, has changed this view. This book is on Tuberculosis, how the tubercle bacillus affects the human organism, and how its ravages are best prevented. It includes under one cover a large amount of information which in the ordinary way is scattered under various sub-specialities, and stresses the view that tuberculosis is an entity and not a disease of various organs. Professor Heaf is responsible for the instruction of post-graduates who are sitting for a diploma in tuberculosis at the University of Wales, and it is probable that he had the needs of these students in mind when he conceived this book. As with every book which is the work of a number of authors, the various sections are uneven in their quality and there is some overlapping. Professor Heaf's introduction is masterly, and the whole book is very strong in its emphasis on the prevention and the public health side of tuberculosis. Dr. Geddes' section is admirable in this respect. A very adequate summary of the present knowledge of pulmonary tuberculosis and its treatment appears under Dr. Hudson's name, and it is noteworthy how up-to-date this section is. It is a pity that the same cannot be said of the main section on Non-respiratory Tuberculosis. Here the sections on treatment appear to be somewhat out-of-date. Streptomycin is referred to, but neither isoniazid nor PAS appears as a drug for treatment in this section. It is particularly surprising that in the subsection dealing with the treatment of tuberculous meningitis isoniazid is not referred to. Dr. Macpherson is allotted only 17 pages on tuberculosis in childhood, and so far as it goes this section is excellent, but it seems a pity that when she has been allotted so little space nearly three pages should be taken up in dealing with tuberculin tests, which are also covered very fully in another part of the book. These criticisms of detail do not mean that the book is not considered by your reviewer to be extremely valuable, and well worth the attention of all those who are dealing with tuberculosis, especially from the public health point of view. The reproductions of X-rays and the whole set-up of the book are admirable, and Professor Heaf is to be congratulated on producing such a volume.

F. H. YOUNG.

NAPT Handbook of Tuberculosis Activities, 15th Edition. Publishers: National Association for the Prevention of Tuberculosis. Pp. 376. £2 10s.

The 15th edition of the NAPT Handbook of Tuberculosis Activities sets out the present-day position admirably. The place of the General Practitioner, the Chest Specialist and the Medical Officer of Health in relation

to the Tuberculosis schemes is well documented and the Preventive and Curative services are outlined, even though they are in separate sections. Despite advances and progress, it must be remembered that tuberculosis remains the major infectious disease encountered in England and Wales, and this Handbook maintains the high standard of previous editions and is a fund of information to all those interested in tuberculosis, not only in Great Britain but in the Irish Republic and the British Commonwealth. The editors are to be congratulated on this new publication.

PHILIP ELLMAN.

B.C.G. and Vole Vaccination. Edited by K. NEVILLE IRVINE. 2nd Edition. London: National Association for the Prevention of Tuberculosis. 1957. Pp. 108. Illus. 15s. net.

The second edition of this compact book contains all recent information concerning B.C.G. and vole vaccination. The first two chapters give a brief account of the historical background and theory of the subject. All those performing vaccination would be well advised to read carefully the sections on technique.

It is a pity that there is no uniformity in tuberculin testing. The value of the Heaf test is stressed as one that can be performed (but not read) without skill.

The answer to the burning question, How long does vaccination last? is still awaited. Until this is known the author's suggestion of abandoning conversion testing of non-exposed school children must be postponed.

It is of interest that the only relevant complication of intracutaneous B.C.G. vaccination, abscess formation in the regional lymph nodes, is much more frequent in the first year of life.

The author has not tried to force his opinion but rather to illustrate by factual data the clear value of anti-tuberculous vaccination.

LESLIE G. ANDREWS.

Topographische Ausdeutung der Bronchien im Rontgenbild, unter besonderer Berucksichtigung des Raumfaktors. By CLAUS ESSER. Stuttgart: Georg Thieme Verlag. Pp. 210. 89 illustrations. DM. 58.

This very useful book deals with the radiological interpretation of the bronchial tree. In the introduction the author discusses at some length the anatomy and nomenclature of the bronchi. It becomes quite apparent from reading these pages that as yet there is no uniformity, nor has full agreement been reached, in the various countries on the point of nomenclature.

The actual radiographic interpretation of the bronchial anatomy is based primarily on the careful analysis of bronchograms, and secondly, on a detailed study of tomograms of the lung taken in various planes. There is a very competent description of the techniques employed for the demonstration of individual bronchi of the right and left lungs, and also for the demonstration of minor sub-segments of the lung by both tomographic and bronchographic methods. The normal appearances are described in detail, and also many anatomical variations of the bronchial anatomy, a valuable feature which will help appreciably those who are interested in the interpretation of the bronchial tree.

The text is profusely illustrated by excellent radiographs and clearly

annotated diagrams. The book ends with a long bibliography which is up-to-date and will be appreciated by all who intend to study the radiographic anatomy of the lungs, and in particular of the bronchi. A great deal of work has been done on this problem in many countries. It is timely that most of the important references have now been brought together in this book. Great credit goes to the publishers for their painstaking production of this monograph.

R. E. Steiner.

Pathological Histology. By Robertson F. Ogilvie. 5th Edition. E. and S. Livingston Ltd. Pp. 482; 334 illus. 52s. 6d.

When Ogilvie's *Pathological Histology* was first published in 1940 it was intended primarily as a textbook to meet the needs of students in the Morbid Histology class, but during the last seventeen years, as successive editions have appeared, the general scope of the book has increased so that now it has become a useful work of reference to a larger number of readers, particularly post-graduate students studying for higher qualifications. The sections dealing with the circulatory and respiratory systems are of special interest in relation to tuberculosis and they give an excellent account of the minute effects of disease on the tissues. The book is profusely illustrated with beautiful coloured photo-micrographs. In this edition the illustrations total 334, and many of these are practically works of art.

Cuthbert E. Dukes.

Lehrbuch der Chirurgie. Edited by Prof. H. Hellner, Prof. Dr. R. Nissen, Prof. Dr. K. Vosschulte. Stuttgart: George Thieme Verlag. Pp. 1059. DM. 84.

This textbook of surgery, which includes contributions from numerous well-known German and Swiss surgeons, is as comprehensive a work on surgery as can be expected in one volume. Possibly in any future editions the matter might be simplified for the reader by having it in two less cumbersome books. The work represents the present outlook and practice of German surgery and it is up-to-date and authoritatively written. There are a number of excellent illustrations and each section is almost complete in itself.

Dealing with the chapters on pleura, lung and heart, there is a concise and adequate discussion on the pathology of all the main diseases. Descriptions of actual operations are not gone into in any detail, but the principles of handling individual conditions are clearly indicated. Perhaps the section on cancer of the lung is rather briefer than it might be in view of the importance of this disease. The chapter on surgical conditions of the heart is a model of how much can be clearly incorporated into a limited space. All the current procedures are well illustrated and their relative difficulties and results described. The X-rays and diagrams are clear and carefully chosen.

The chapters on the diaphragm and œsophagus by Professor Nissen are also lucid and informative.

T. Holmes Sellors.

BOOKS RECEIVED

The following books have been received and reviews of some of them will appear in subsequent issues.

The Anatomy of Congenital Pulmonary Stenosis. By Sir Russell Brock. London: Cassell and Co. Ltd. Pp. 114. 30s.

Sir Robert Philip (1857-1939). Edited by Harley Williams (13 authors). London: National Association for the Prevention of Tuberculosis. Pp. 96. 12s. 6d.

B.C.G. Vaccination against Tuberculosis. By Sol Roy Rosenthal. London: J. and A. Churchill Ltd. Pp. 389. Illus. 55s.

British Student Tuberculosis Foundation 1956/7. London: British Student Tuberculosis Foundation Ltd. Pp. 89. Illus.

Tuberculosis Nursing. By Jessie G. Eyre. 2nd Edition. London: H. K. Lewis and Co. Ltd. Pp. 354. 25s.

The Surgical Management of Pulmonary Tuberculosis. Edited by John D. Steele. Illinois: Charles C. Thomas. Pp. 213. 72s.

A Study of the Course of Pulmonary Tuberculosis after Treatment with Thoracoplasty. By Alexander Tuxen. Copenhagen: Ejnar Munksgaard. 1957. Pp. 184.

Exudative Tuberculous Pleurisy. By Sven-Olof Berlin. Copenhagen: Ejnar Munksgaard. 1957. Pp. 134.

Selektive Lungenangiographie. By Prof. Dr. Wilhelm Bolt, Prof. Dr. Werner Forssmann and Dr. Hans Rink. Stuttgart: Georg Thieme Verlag. Pp. 199. DM 54.

Die Heutige Behandlung der Skelett-Tuberkulose des Kindes und des Jugendlichen. By Dr. G. Glogowski, with foreword by Prof. Dr. Max Lange. Stuttgart: George Thieme Verlag. Pp. 61. Illus. DM. 10.80.

The Infectiousness of Human Tuberculosis. By Gerh. Hertzberg. Copenhagen: Ejnar Munksgaard. Pp. 146.

REPORTS

JOINT TUBERCULOSIS COUNCIL

A MEMORANDUM from the Council indicates that its objects are as follows:

1. To co-ordinate the work of organisations interested in the study and control of tuberculosis and associated diseases, in Great Britain and Northern Ireland.
2. To promote study and research.
3. To provide a Committee of reference, representative of those interested in tuberculosis and associated diseases, which will consider questions referred to it by Government Departments, Regional Hospital Boards, Local Authorities, and other groups and individuals interested in tuberculosis and allied problems.

Among its activities have been the following:

In 1946 the Council was invited by the Ministry of Health to participate in the preparation of the Ministry's memorandum on notification.

It published its memorandum on Mantoux Conversion in Nurses and its first report on the protection of organised groups of children from tuberculosis

infection by adults in 1947. In 1949 the World Health Organisation asked the opinion of the Joint Tuberculosis Council on a proposed classification of tuberculosis.

In 1950 it circulated a proposed form for medical reports for use in chest clinics and hospitals.

In 1952 the Ministry of Health published as a medical memorandum the report of the joint committee of Joint Tuberculosis Council, Faculty of Radiologists, and Society of Thoracic Surgeons, on standardisation of terminology and technique in chest radiology, and the Council published its second report on the protection of organised groups of children from tuberculous infection by adults.

In 1955 it issued a report on " The Changing Character of Tuberculosis."

In addition the Council has made recommendations on a wide variety of other matters such as:

Tuberculosis in immigrants.
Shortage of nurses and junior medical staff in sanatoria and chest hospitals.
Employment of sputum-positive persons.
Food rationing and tuberculous persons.
Laundry arrangements for the clothing of tuberculous persons.
Diagnosis and assessment of disability in pneumoconiosis.
Regional organisation of tuberculosis services.
Disposal of sputum.
Mass Miniature Radiography.

TUBERCULOSIS FOR ENGLAND AND WALES

Published by the General Register Office, " Tuberculosis Statistics for England and Wales, 1938 to 1955 " discusses the prevalence of tuberculosis to-day, as shown by the figures for notifications of cases and for mortality. It includes a detailed analysis of notification rates in 1954 and 1955 for the larger administrative areas.

Mortality in the past ten years has declined rapidly, largely through antibiotics and chemotherapy. Reduction in notification rates has been much slower. Improved case-finding has meant earlier notification and cases now being notified represent less infectious forms. Mass miniature radiography has revealed many unsuspected active respiratory cases, at the rate of more than 3 per 1,000 of adults examined.

For respiratory tuberculosis, the number of cases, known and unknown, is estimated to be of the order of 375,000, perhaps 45,000 infectious. Control of the spread of infection remains a serious problem and the dramatic decline in mortality and the reduction in notification does not justify complacency. But the downward trend in the prevalence of tuberculosis makes the prospect for prevention encouraging.

NOTES AND NOTICES

NAPT POLICY IN REGARD TO SMOKING AND CANCER OF THE LUNG

The NAPT approves the statement of the Minister of Health that smoking, especially heavy cigarette smoking, is a very important element in the cause of lung cancer. It supports the Minister's decision not to propose drastic measures

of compulsion, but to make this important issue the subject of long-term education.

The NAPT urges the Minister, in consultation with his ministerial colleagues, to review existing regulations for the control of smoking in railway carriages, cinemas, buses, and other places where people congregate.

It has confidence that the Medical Research Council will continue research to clarify further the cancer-producing mechanism, and to discover what degree of cancer risk there is for non-smokers exposed to tobacco smoke, and trusts that the danger of air pollution from other forms of smoke will also be studied intensively.

INTERNATIONAL SOCIETY OF INTERNAL MEDICINE

THE Fifth International Conference will be held in Philadelphia from April 24-26, 1958. The Society was organised in 1948 at the instigation of Professor Nanna Svartz of Stockholm. Dr. T. Grier Miller of Philadelphia will be the President of the Congress.

BRITISH STUDENT TUBERCULOSIS FOUNDATION

THIS Foundation, with Student Units at Pinewood and High Wood Hospitals, was established in 1952 as a result of the successful national appeal launched the previous year by students in universities and colleges throughout the country for students with tuberculosis. The Yearbook for 1956/7 has recently been published.

The aims of the foundation have been formulated in its Memorandum of Association. They are: " . . . to give assistance of any and every kind to students . . . who are suffering from tuberculosis," and in particular " to establish and maintain or provide, or to assist in establishing, maintaining or providing for students, either gratuitously or in return for payment, sanatoria or other curative centres, or accommodation in sanatoria or other such centres, wherein . . . students may continue their studies while under medical supervision."

The first unit was opened in September 1952 for male students, and over 150 students have been in residence at Pinewood since it opened and many have taken excellent degrees on return to the university.

The second unit was opened at High Wood in February 1955 for women students. Some twenty-five students have been in residence, and already excellent academic results have been reported from students who have since returned to their universities and colleges.

The third Student Unit was opened in November 1956 at Tor-na-dee Sanatorium, near Aberdeen. This caters primarily for Scottish students of both sexes who need treatment for tuberculosis.

The medical care and maintenance of student patients at these three centres are accepted by the appropriate Regional Hospital Boards under the terms of the National Health Service. The Foundation is responsible for academic administration and all services over and above those usually provided. Further details of the work of the Foundation can be obtained from the Secretary/Administrator, at 59, Gloucester Place, Portman Square, London, W.1.